PERFORMANCE ANALYSIS IN AGRICULTURE USING DATA ENVELOPMENT ANALYSIS

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Abstract
The objective of this article is to analyze and evaluate the performance of Romanian agriculture, using a set of specific indicators having as reference system the EU agriculture. In order to highlight the particularities of agriculture, on the one hand, we carried out a case study on the dynamics of the main indicators of financial performance in Romanian and EU agriculture. On the other hand, we carried out an analysis of the regional performance of the Romanian agriculture, using Data Envelopment Analysis. The data needed for the analysis come from the FADN being for the period 2014-2017. The results of this study represent an important informational support in the decision-making process in the development of the agricultural sector and at the same time it highlights the use of resources in generating results.

Key words: *agriculture, Data Envelopment Analysis, performance.*

JEL Classification: *Q18, M21*

I. INTRODUCTION

The Romanian rural territory has a significant agricultural potential due to the available natural resources, so that Romania represents 7% of the utilised agricultural area of the European Union, occupying the 6th place. Romania had at its disposal important European funds through the CAP for alignment with the European requirements and market conditions, but there are a number of imbalances in the Romanian rural economy, due to the large number of small farms and the low degree of technology. In Romania there are the largest number of farms in the EU, of which about 90% are subsistence farms, and some have very large sizes. The excessive division of agricultural land and the establishment of a large number of agricultural farms led to the decrease of agricultural productivity, the extension of poverty in the rural area, the inefficient use of the production factors.

The common agricultural policy (CAP) is a system of agricultural subsidies and programs of vital importance, its philosophy evolving over time but improving agricultural productivity remains one of its main objectives. Due to its importance for the rural economy, the CAP is a widely debated topic, with a widely asked question referring to the extent to which the CAP has achieved the objective of contributing significantly to the productivity growth. The answers to this question are varied, being approaches that result in the positive effect of the CAP (Knight and Bentoneche, 2001), others highlight the negative impact (Rizov, 2013). The major challenges facing the CAP have started from economic, social and environmental changes, as well as from huge heterogeneities within the EU, due to its expansion to the east. Therefore, a re-evaluation of its role is needed (Duquenne et al, 2019).

The CAP after 2020 aims at the transition to a fully sustainable, intelligent, competitive agricultural sector, the development of dynamic rural areas, which will provide safe and high quality food.

The objective of this approach is to evaluate the financial performance of the Romanian agriculture, at national and regional level, based on a set of indicators that highlight the position and financial performance, using as a reference system the EU agriculture.

The research hypotheses considered are:
1. The EU agriculture performance is superior compared to the Romania agriculture
2. The performance of agricultural holdings at Romanian regional level shows an oscillating evolution.
This research complements the results of a previous study carryed out by the author, which refers to the evaluation of the economic performance of the Romanian agriculture by analyzing the relationship between the obtained results and factors of production (Bumbescu, 2019).

II. LITERATURE REVIEW

The performance represents a state of competitiveness of the organization which, on the one hand, determines the achievement of results due to the achievement of strategic objectives, and on the other hand, ensures the sustainable maintenance on the market (Jianu, 2007). The performance consists of the efficiency and effectiveness with which the resources (effort) are consumed and the results (effects) generated that ensure the development of the sphere of interest of the organization (Petcu, 2009). The performance evaluation indicators are diverse and reflect the degree of capitalization of available resources to achieve the desired / planned results. The annual financial reports of the organizations facilitate the monitoring and evaluation of the performance with

the help of financial indicators (Burja and Burja, 2015). The financial indicators provide a real basis for analyzing the performance and evaluating the financial health of the company (Knight and Bentoneche, 2001).

Data Envelopment Analysis (DEA) is a non-parametric linear programming method that is used to evaluate the efficiency of decision-making units (DMUs), such as: organizations, institutions, countries, sectors of activity.

In agriculture, DEA it has been used to analyze the relationship between farm size and efficiency of production factors (Bumbescu, 2019), to determine the competitiveness of the agricultural sector (Rasmunssen, 2010), to analyze the regional performance of agriculture using financial indicators (Burja and Burja, 2015), to evaluate the efficiency of production (Aldea and Vdican, 2007).

The initial version of DEA model (proposed by Charnes, Cooper and Rhodes in 1978) was made taking into account a constant rate of production growth in relation to the growth associated to the production factors (CRS model- constant return to scale), and subsequently Banker, Charnes and Cooper in 1984 developed the model based on a variable rate of output growth in relation to the growth associated with production factors (VRS-variable return to scale model) (Subhash, 2004). The above models-CRS, VRS- can be oriented to input or output. Choosing an input or output oriented model depends on the DMUs characteristics. The difference between the CRS and the VRS model is that the latter adds a variable in both the input and output models (Mecit and Alp, 2013).

DEA method involves combining multiple inputs and outputs and transforming them into an efficiency index. This approach starts from establishing an "efficiency frontier" (score 1), for all DMUs that present the best practices and then assigns the efficiency level to other decision-making units according to their distances from the effective frontier. If the score is high, the economic system analyzed is efficient.

The CRS model considers k decision units that each use a number of n inputs and m outputs, the calculation formulas being presented below (Burja and Burja, 2016):

The efficiency for the decision-making unit k is calculated as follows:

$$E_k = \frac{\sum_{j=1}^{m} v_j y_{kj}}{\sum_{i=1}^{n} u_i x_{ki}} \qquad (1)$$

$$\frac{\sum_{j=1}^{m} v_j y_{kj}}{\sum_{i=1}^{n} u_i x_{ki}} \leq 1 \qquad (2)$$

$$\forall u_i, v_i \geq 0$$

u_i - represents the share of production factors (x); v_j - represents the share of production (y).

These efficiency relationships can be transformed into a linear programming model that aims to achieve an output oriented models or an input oriented models. For each decision unit k, the following model is used:

$$\max \sum_{j=1}^{m} v_j y_{kj} \qquad (3)$$

$$\sum_{i=1}^{n} u_i x_{ki} = 1 \qquad (4)$$

$$\forall u_i, v_j \geq 0$$

$$\sum_{j=1}^{m} v_j y_{kj-} \sum_{i=1}^{n} u_i x_{ki} \leq 0 \qquad (5)$$

III. DATA AND METHODOLOGY

In order to carry out this study, were collected data regarding commercial agricultural holdings in Romania and the EU. The information comes from the European Commission's Farm Accounting Data Network (FADN) database, https://ec.europa.eu/agriculture/rica/database/database_en.cfm, which contains information on farms in EU member countries. In the category of commercial agricultural holdings are included only those farms that have a certain size to ensure a sufficient income for farmers to support their family.

The indicators used are calculated as financial rates that express the profitability, liquidity, solvency and efficient use of resources, both in agricultural holdings in Romania and in the EU as a whole, for the period 2014-2017. In order to obtain complex and detailed information on the phenomenon studied, a centralization of information was made (for input and output variables) for the 7 development regions of Romania (North East, South East, South Muntenia, South West Oltenia, West, North West, Center). We mention the fact that the Bucharest Ilfov region was not included in this research because it has an atypical structure, its contribution in agriculture being reduced.

The evaluation of performance in agriculture using DEA was done through two results-oriented models (output oriented), namely the CRS model and the VRS model. For this purpose, the return on assets (ROA) was used as the output variable and as input variables: economic rate of return, total asset turnover, total production, net worth, net value added, liquidity, solvency, gross income.

ROA it is calculated as the ratio between the net income and the total assets held by an entity.

The economic rate of return is a way of measuring the performance in terms of asset use (Hristea, 2015). It is calculated as the ratio between gross income and total assets.

The total assets turnover is calculated as the ratio between the total production and the total assets.

The total production expresses the total value of the agricultural production that comes from the vegetal and zootechnical sector.

The net worth is calculated as the difference between total assets and total liabilities.

The net added value ensures the remuneration of all employed production factors, the level of this influences the efficiency of agricultural holdings.

Liquidity involves examining the relationship between current assets and current liabilities to determine if the company can meet its short-term payment obligations (Friedlob and Schleifer, 2003).

General solvency is calculated as the ratio between total assets and total liabilities.

Gross income is determined as follows: the value of total production - intermediate consumption + subsidies and taxes. Its level highlights the use of all resources.

In order to achieve the established research objective, in the first stage we will present in table no. 1 an overview of the main indicators of agricultural performance in Romania and the EU, in the period 2014-2017.

Table 1 Performance indicators of agriculture in Romania and EU in the period 2014-2017

Indicators	UM	Romania- average per farm				UE- average per farm			
		2014	2015	2016	2017	2014	2015	2016	2017
ROA	%	14,93	10,15	13,67	15,69	5,32	5,06	5,25	5,96
Economic rate of return	%	21,18	16,64	20,41	22,26	11,32	11,06	11,24	11,85
Current liquidity		13,90	9,30	12,94	14,24	5,59	5,47	5,85	5,90
General solvency		33,41	22,87	31,68	36,16	6,40	6,21	6,23	6,37
Total asset turnover		0,33	0,30	0,32	0,34	0,22	0,21	0,21	0,22
Total production	Euro	11.434	10.734	11.787	13.088	70.929	71.921	71.585	76.097
Net value added	Euro	6.090	4.556	6.142	7.109	27.999	28.149	29.099	32.476
Net worth	Euro	33.507	33.678	36.076	37.273	276.387	284.067	286.645	297.754
Venitul brut	Euro	7.316	5.860	7.604	8.533	37.070	37.445	38.371	41.839
Net income	Euro	5.156	3.576	5.092	6.014	17.439	17.130	17.934	21.042
Total assets	euro	34.541	35.218	37.252	38.333	327.575	338.569	341.425	353.209

Source: author's views based on FADN data

The information for table no. 1 highlights significant differences between the Romanian and EU agriculture in terms of the level and dynamics of the analyzed indicators.

The results obtained in Romanian agriculture, in the period 2014-2017, register lower values compared to the EU average. Thus, the total production is approximately 6 times lower in Romania, which determines that the incomes and the net value to register a similar trajectory:

➢ gross income and the net added value are about 5 times lower in Romania compared to the EU
➢ net income is approximately 3,5 times lower in Romania compared to the EU; the net worth is about 8 times lower in Romania.

If we analyze the resources necessary to obtain the production and the incomes, we find the same significant discrepancies between the potential of Romanian and EU agriculture. The total assets held by EU

agriculture are 9,5 times higher than Rmanian agriculture, and the current assets are 10 times higher. On the other hand, the total debts of EU agricultural holdings are 44 times higher compared to Romania.

Regarding the indicators that highlight the performance of the agricultural exploitations from Romania and the EU presented in the table no. 1, they generate a series of relevant and distinct aspects compared to those presented above. If we perform an overall analysis, the average level of these indicators, in the period 2014-2017, is higher in the case of agricultural holdings for Romania compared to the EU:

➢ the return on assets (ROA) average is 8,21% higher in the case of agricultural holdings in Romania compared to the EU, economic rate of return registering similar values, being by 8,75% higher in the case of agricultural holdings for Romania;

➢ current liquidity and general solvency, calculated as average values, register lower values in EU agricultural holdings compared to Romania, so that the liquidity is about 45% higher and solvency is with 80% higher in Romania;

➢ the average of total assets turnover is 34% higher in Romanian agriclture compared to the EU.

Taking into account the level of the *liquidity rate*, the short-term financial balance is reached, the agricultural holdings for Roamnai and EU can pay their current debts from the current assets they own. On the other hand, the high level of the current liquidity, especially of the agricultural holdings for Roamania, is a negative aspect because it shows that they have a significant capital invested in stocks and receivables, so they have not adopted an efficient investment policy.

General solvency. The level of general solvency highlights the fact that agricultural holdings, especially those in Romania, have low debts and high solvency. This indicates that there is a high level of financial security and that they mainly use their own capital for development. The fact that they did not take out long-term bank loans can be explained by inadequate lending conditions, by the excessive prudence of the banking sector in lending the agriculture and by inadequate development strategies of agricultural holdings.

The total asset turnover highlights the ability of management to obtain results using the available means. During the analyzed period, in the agricultural companies for Romania and EU, this indicator registers inappropriate values, being in the range of 0,21-0,34 rotations. If we refer to the growth rate of total assets, they increased by 11% in Romania in 2017 compared to 2014 and by 8% in the EU in the same period, while the total production decreased by 6% in 2015 compared to 2014 in Romania and increased by 1,4% in the EU in the same period. This situation reflects the inefficient use of assets in generating economic effects.

The return on assets (ROA) registers high values, which highlights the performance of the activity carried out. However, while the total assets increased throughout the analyzed period, in Romania and in the EU, the net profit has an oscillating evolution, decreasing by 31% in Romania and 1,78% in the EU in 2015 compared to 2014, increases by approximately 18% in 2017 compared to 2016 in Romania and in the EU. The oscillation of the net income obtained from assets, especially its significant decrease in certain periods, while total assets increase, highlights an inefficient management of resources in generating increased economic effects, but at the same time must take into account the impact of the tax system.

The economic rate of return reflects the performance of the agricultural assets, independent of its financing mode (own or foreign capital) and the fiscal system, reflecting the profit obtained as a result of the invested capital. During the analyzed period, in Romanian and EU agricultural companies, the economic rate of return have high values, which reflects the performance of the total assets. This indicator has higher values in the case of agricultural holdings for Romania, an average of approximately 20%, compared to the EU, the average being 11%. In the case of EU agricultural companies it is observed that the increase of the total assets leads to the increase of the gross income. In Romanian agricultural companies, the situation is different, registering an oscillating evolution, so that the increase of assets by 1% (in 2015 compared to 2014) leads to a decrease of gross income by 20%, while in 2017 compared to 2016 gross income increases by 12% and total assets by 3%. If we analyze the growth rate of the results obtained (gross income) by using available resources (total assets), we can say that the activity carried out is situated in the performance parameters except for the period 2014-2015 when in Romania there is a significant discrepancy between the use of resources and the results generated.

The regional performance of Romanian agriculture is influenced by a series of factors: utilised agricultural area, soil fertility, climatic conditions, etc.

An overview of the performance of Romanian agriculture by development regions is made with the DEA as shown in table no. 2.

Table 2 The performance of Romanian agriculture, by regions, in the period 2014-2017 using DEA

Regions	2014		2015		2016		2017	
	CRS	VRS	CRS	VRS	CRS	VRS	CRS	VRS
North-East	1	1	1	1	1	1	1	1
South-East	1	1	0.9	0.92	0.88	1	0.9	1

South-Muntenia	0.78	1	0.9	1	1	1	1	1
South-West Oltenia	1	1	1	1	0.85	1	0.95	1
West	0.9	0.9	0.77	0.8	0.98	1	0.92	0.97
North West	1	1	0.810	1	0.99	1	0.92	1
Center	0.98	0.98	0.78	0.9	0.94	0.97	0.8	0.86
Romania-mean	**0.95**	**0.98**	**0.88**	**0.95**	**0.95**	**1.00**	**0.93**	**0.98**
Output variable: ROA Input variable: economic rate of return, total asset turnover, total production, net worth, net value added, current liquidity, general solvency, gross income								

Source: author's views based on FADN data

According to the obtained results, the agricultural holdings for a single region (North-East) register a relative efficiency for the entire analyzed period 2014-2017, in the case of both models used, CRS and VRS. In the case of using the VRS model, it is found that in addition to agricultural holdings in the above-mentioned region, it carries out a high-performance activity those for the regions of South Muntenia, South West Oltenia, North West.

The average efficiency score for the commercial farms in Romania is 95% in 2014, recording an oscillating evolution with the tendency to decrease, so that compared to 2014 it decreases by 7,5% in 2015, 2,5% in 2017, in 2016 remains the same value as in 2014. The decrease of economic performance can be a consequence of the inefficient use of production factors in generating economic effects and implicitly of the funds destined to agriculture through European programs and projects.

In 2014, 35% (391,320 farms) of the total agricultural holdings did not reach the expected level of performance and are in three regions with efficiency scores below "1", South Muntenia, West and Center. In 2017 there is an unfavorable evolution of this phenomenon, so that 700.430 farms, which means 62% of the total, have not yet reached the level of performance and are located in five regions: South East, South West Oltenia, West, North West and Center.

Under the given conditions, in the case of agricultural holdings identified as having lower efficiency scores, it is necessary to take concrete measures which, from our point of view, aim at the following:
➢ improvement of economic and financial strategies
➢ adopting reasonable strategic decisions on asset and capital management that need to accelerate the assets turnover in order to contribute more to revenue growth
➢ diversification of investment strategies by using different financing sources so to increase the productive potential and become more competitive.

IV. CONCLUSIONS

The notion of performance in agriculture is a complex one, it can be expressed in different forms, being influenced by a number of internal and external factors, especially in the context of the global warming phenomenon that puts its mark on agriculture, especially in the countries where irrigation infrastructure is poorly developed as is the case in Romania.

Due to the significant number of variables taken into account in order to analyze and evaluate the performance of Romanian agriculture compared to the EU, it is difficult to make a general valid assessment regarding the indicators that show the superior performance of the EU agriculture compared to Romania.

According to the information presented above, the variables that highlight that the performance of EU agriculture is superior compared to Romanian agriculture are: total production, gross income, net income, net value added, total assets, thus verifying *research hypotheses no. 1*. On the other hand, the financial indicators such as the return on assets, the economic return, the current liquidity, the general solvency, the total asset turnover, highlight the fact that the performance of Romania's agriculture is superior compared to the EU.

Given the complexity of this research hypothesis, although the figures prove its validation, the detailed analysis of causes and effects, can generate a distinct approach that highlights the fact that the situation from a strategic point of view and taking into account all factors, can cause an invalidation of the hypothesis, the difference being given by the way of approaching the issue and the depth of the approach. The first natural question that arises is, in the context in which the immediate economic effects (production, gross and net income, net added value) and the efforts necessary to obtain them (assets) are clearly inferior in the case of Romanian agriculture, why profitability, liquidity and solvency is it at the opposite pole being lower in the case of EU agriculture? It is important to point out that the values recorded by the indicators for measuring the performance of EU agriculture, although lower compared to Romania, have a very good level, to which if we add the following conclusions, the situation can be seen from a distinct perspective:

➤ the high level of current liquidity is a negative aspect because it shows that agricultural holdings have significant capital invested in stocks and receivables, so they have not adopted an efficient investment policy

➤ the high level of general solvency shows that the Romanian agricultural companies have low debts, they use in particular their own capital for development without focusing on long-term bank loans, a significant part of the loans are used to finance the current activity to the detriment of the investments that generate long-term development

➤ the oscillation of the income obtained by using the assets, especially its diminution, while the total assets increase, highlights an inefficient management of resources in generating increased economic effects.

The results of this study highlight the oscillating performance, with the decreasing tendency, of agricultural holdings in Romania, although our country has significant resources and a favorable agricultural potential, thus verifying *research hypotheses no. 2* which refers to the fact that the performance of agricultural holdings in the development regions of Romania registers an oscillating evolution. Therefore, a restructuring and reorganization of agricultural holdings is required so that an efficient use of the resources will take place, which implicitly will lead to the development, progress and performance of agriculture.

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