NONPARAMETRIC METHODOLOGY FOR THE RATING EVALUATION OF SUSTAINABLE RURAL DEVELOPMENT IN THE REPUBLIC OF MOLDOVA

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Abstract

The main objective of the paper is to develop the nonparametric methodology for the evaluation of the rural localities development level. To accomplish this task, it is necessary elucidating the weaknesses and threats of sustainable rural development and reflecting them in the Strategy for the Development of Agriculture and Rural Area of the Republic of Moldova for the years 2014-2020. For the realization of this tasks in the research methodology we had done the theoretical foundation of the sustainable rural development by elaborating the survey of households and defining the economic indicators based on the principal component analysis. The elaboration of the nonparametric methodology for evaluating the sustainable rural localities development level is done by identifying theirs rating based on the IPAR_TFP software. It is done a comparative analysis of the districts of the Republic of Moldova according to the sustainable development level in order to identify the economic-social factors share within the basic compartments of the rural area.

Key words: rural development, rating, total factor productivity, principal component analysis

INTRODUCTION

Complex development of the rural area represents an objective of national importance, taking into account the conditions offered by the perspectives of eventual European Union membership. The process of transition from the centralized economy to the market economy has generated numerous economic and social issues in the agriculture and the rural economy of the Republic of Moldova. The traditional methods used in the rural economy and the social development of the region do not have a similarity with the market principles of the European Union and represent a trend in the domestic agrarian policies. Thus, a modern approach is required, taking into account that the rural area has a large variety of local resources, which being developed according to sustainability standards, leads to its development. About 58% of Moldova's population lives in rural areas, becoming the country with the highest share of rural population in the Eastern Europe. Despite this fact, the unemployment rate in the villages reaches almost two thirds of the population, being largely determined by the low wages in the agricultural sector. The degradation of the managerial techniques of organizing the agricultural production imposed a massive process of depopulation of Moldovan villages, especially young people and those who obtained an education level. The social factors that have forced a massive departure of the population from the agricultural sector in the European Union as a labor force has caused a flow of financial resources in the country that even today remain the basic source of income for rural families. The poor state of the infrastructure is another factor that limits the development possibilities of the rural localities in the country. In this way, the initiation of the academic economic research within the State Agrarian University of Moldova to elucidate the factors that can define a solution of the transition crisis to the market economy in the agricultural sector of the country is a great necessity for the adequate formulation of the agricultural policies of the Ministry of Agriculture, Regional Development and Environment.

Table 1 Evaluation of the rural development level in the Republic of Moldova depending on the significant factors of the basic components depending on the significant factors of the basic compartments of the areas

Social component				Ecological component				Economic component				R
Age	Education	Basic occupation	Family members work in the village	Water supply system	Sewerage system (WC with water)	Home heating system	Fuel for: a) heating b) cooking	Agricultural farm (area, ha)	The plot next to the house (area, ha)	Total consumption, lei	Total income, lei	Rural development level
57	2	1	2	2	2	2	2	2,990	0,060	24300	67000	0,911
39	3	4	0	1	1	1	2	0,000	0,150	0	0	1,000
77	3	8	0	2	3	2	2	0,000	0,160	0	0	0,826
63	3	8	0	2	3	2	2	0,000	0,270	0	0	0,953
64	3	8	0	1	3	1	2	0,000	0,120	0	0	1,000
48	5	6	0	2	3	2	2	0,000	0,190	0	0	0,823
49	4	4	0	1	0	2	2	0,000	0,210	0	0	0,859
39	2	7	2	1	2	1	1	2,260	0,150	10300	0	0,733
66	1	6	0	1	2	1	2	0,000	0,250	0	0	1,000
59	3	4	3	1	2	2	2	0,000	0,300	0	0	0,838

The primary data necessary to develop the nonparametric methodology were obtained as a result of the surveys carried out in the communes from Ialoveni, Calarasi, Orhei, Telenesti, Causeni and Briceni districts. In six districts of the Republic of Moldova, 911 households were surveyed. Questionnaire represents a structure of the survey divided into three basic components of the rural area. The variables related to component 1 that refer to the social activity of the study object include 13 significant factors of the rural population activity with special references to the human, educational and economic characteristics of the localities.

The 2nd part of the survey is mainly focused on the information regarding the ecological situation of the rural area with special notification that relates to the supply with drinking water, the sewerage system, the types of home heating system and other factors. This compartment is represented by 11 exogenous variables that have a causal effect on the rating of the sustainable development.

The 3rd part emphasizes the economic issues, i.e. it reflects the data on the area of land owners, the types of agricultural crops cultivated in the area, the animal breeding sector being separately mentioned, the consumption and others. Related endogenous variables are grouped into 10 types of activity and represent an important support in the factorial analysis of the primary data set. The database developed as a result of the survey is defined by the format of the SPSS software.

The elaboration of the methodology for determining rating of the rural development requires some techniques for comparative factor analysis of the variables included in the nonparametric model. This approach could be described as a procedure whereby the primary data set, collected due to the household survey including 34 indicators divided into three basic components, can be minimized by the number of distinct factors included in the model. It should also be noted that, the technique of reducing variables assumes that a significant factor includes the variables which have a major correlation coefficient between them and traditionally represent a type of activity in the similar rural

area. In the research we have to reduce the set of variables that come from the structure of the household survey to a limited number of integrated factors which broadly represent the basic types of activity in the rural area.

MATERIAL AND METHODS

The total factor productivity method (TFP) seeks to find which of the N households of the primary data set determines an envelopment surface. This envelopment surface refers to the function of empirical reproduction or the limit of absolute performance. The TFP provides a comprehensive analysis of the sustainable rural development level relative to the multi-input, multi-output situations in order to evaluate each economic unit and to measure its development level in comparison with the surface area determined by the other households. Using the duality from linear programming, we can determine an equivalent envelopment form of this problem:

$$
\begin{cases}
\min_{\theta, \lambda} \theta \\
-y_i + Y\lambda \geq 0 \\
\theta x_i - X\lambda \geq 0 \\
N_1 \lambda \leq 1 \\
\lambda \geq 0
\end{cases}
$$

where

θ- represents the parameter regarding the sustainable development level of the household surfaces;

n – is the number of households;

Y- represents the n-dimensional vector of outputs;

X – is the n-dimensional vector of inputs, which is given by the social economic indicators of the rural area X1..X7;

N1 – is a n-dimensional vector with 1 component;

λ- represents the variables of the linear programming problem that will be solved.

The value of technical efficiency $\theta \leq 1$, where a value equal to 1 represents a point on the frontier, therefore a technical firm with absolute performance. The processing of the primary data for the evaluation of the TFP

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rating was carried out using the IPAR_TFP software and is presented in Table 1. The method of the rating evaluation in the sustainable rural development needs the version Variable Return to Scale to the soft.

RESULTS AND DISCUSSIONS

While promoting the National Strategy for Rural Development, it is important to develop a nonparametric methodology for determining the rural development level.

The proposed methodology may be useful for defining the significant factors in identifying and solving major problems in the area and also can help in determining the optimization criteria for the agricultural sector. In the research, this Strategy can also be used as a tool for planning and programming all the necessary measures, as well as obtaining financial support from the country administration, international development partners, international financial institutions and donors, in order to successfully implement the optimization of the rural area. Figure 1 presents the comparative analysis of the rural development level within the districts of Ialoveni, Calarasi, Orhei, Telenesti, Causeni and Briceni. The communes surveyed in different districts presented a different number of respondents who answered the survey questions. For example, 241 households were surveyed in Ialoveni district, 185 in Briceni district and only 99 respondents answered the survey in Orhei district. It is obvious that the districts of Ialoveni, Causeni and Briceni with a well-planned rural space structure have a development level higher than the average on the survey.
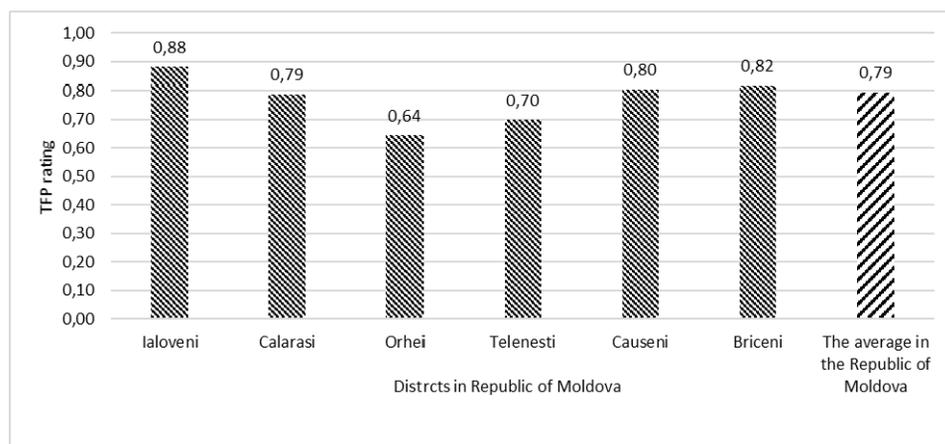

Fig. 1. Comparative analysis of the rural development level in the districts of the Republic of Moldova
The values are the average in the sample of evaluation
Source: Own calculation based on data of the survey.

It is known that education has a major influence in assessing the level of sustainable development of the rural area and represents the exogenous variable with a high share in the TFP rating. The agricultural education system has become responsive and flexible to the demands of the rural labour market.

As a result of the partnership relations between the educational institutions and the companies activating in the field of agriculture and the manufacturing industry, the curricula content for all the 23 related specialities, the teaching methods and techniques are updated on a regular basis in order to ensure a competency-based educational system. Figure 2 presents the TFP rating for the heads of households depending on the studies obtained in the field of agricultural sciences. The minimum value of the rural development level $R = 0.72$ is assigned to people with incomplete secondary education and is an index lower than the national average. Higher agricultural education represents a decisive factor in the performance of the rural area through a higher

TFP rating R = 0.90. The reform of the educational system in the rural area aims at increasing the training level of teachers and at improving the teaching-learning methods, thus contributing to the development of the competency-based education.
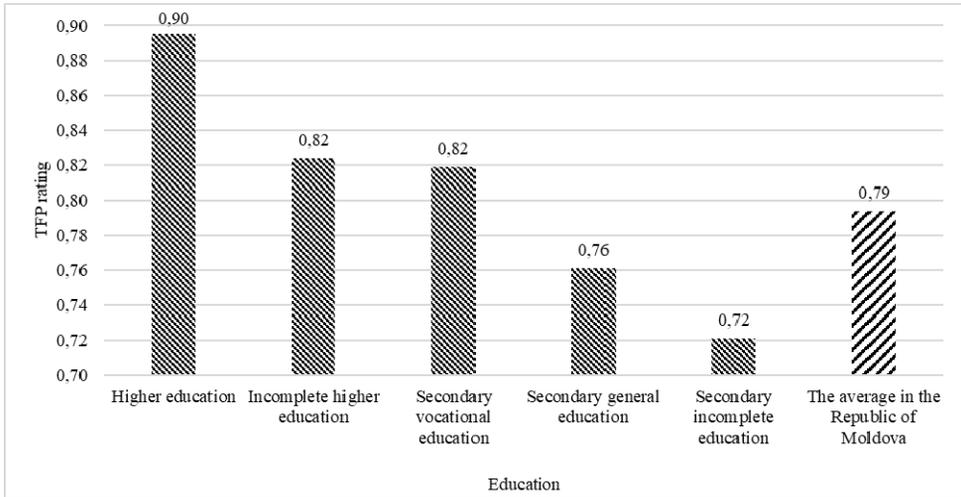

Fig. 2. Evaluation of the rural development rating depending on professional education level
Source: Own calculation based on data of the survey.

The new system aims both to prepare high school students for the baccalaureate exam and to ensure the continuity of the graduates' studies, due to the transferrable credit system. Similar to the education system, the agricultural research and innovation system has failed to completely detach itself from the past and rebuild an appropriate connection with the private sector, continuing to operate relatively isolated and inefficient. The system of applied research in agriculture is currently represented by 8 state institutions, including the State Agrarian University of Moldova.
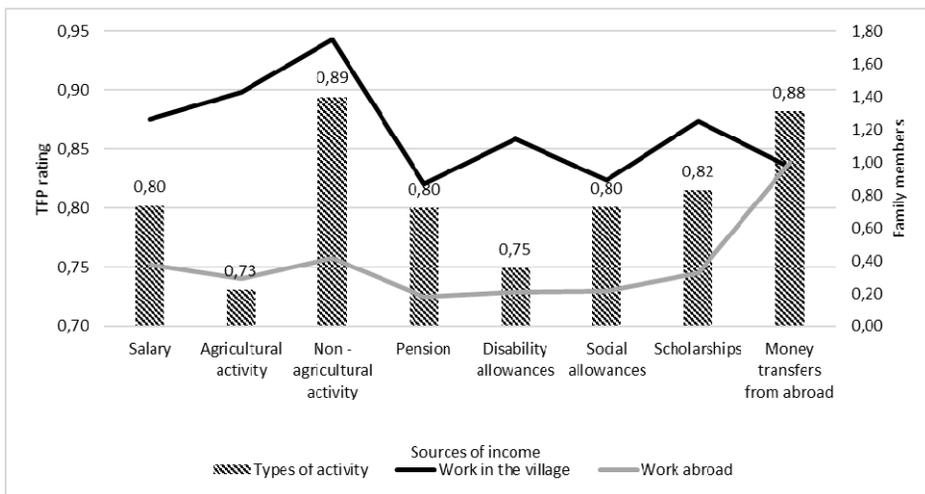

Fig. 3. Evaluation of the rural development level depending on the types of activity and involvement of family members in working activities in the village or abroad
Source: Own calculation based on data of the survey

Figure 3 presents the evaluation of the rural development level depending on the types of activity and involvement of family members in working activities in the village or abroad. Obviously, the households involved in the non-agricultural activity have a net TFP rating higher than the respondents who have salaries and wages from agricultural activities as an income source. People who have relatives working abroad have a very high rating of R = 0.88.

The evaluation of rural population welfare expectancy using the TFP rating shows that the income of 11746 MDL ensures maximum development level and may be an index of subsidization in the agricultural sector. According to the final draft of the FAO report on the small farmers and family farms in Moldova, there is a significant gap between the absolute level of poverty in the urban and rural areas - 19% of the rural population live at the poverty line compared to 5% of the urban population. About 80% of the population consumption expenditure is spent on food, maintenance bills, clothes, transport and communications, and only 0.6% is used for education. There are also large discrepancies depending on the gender, age, disabilities and education level. The people facing the highest poverty risk are those living in rural households headed by elderly people, single women retired and families including adults with disabilities.
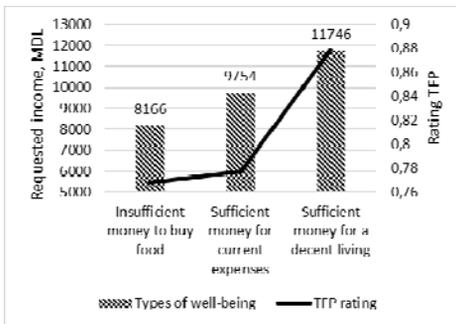

Fig. 4. Welfare expectancy of the rural population assessed through TFP rating
Source: Own calculation based on data of the survey

The ecological component of the rural area can be evaluated by determining the sanitary infrastructure endowment of the households. Figures 4 and 5 present the values of the TFP rating for different districts of the Republic of Moldova and the possibility of placing the sanitary equipment in the house. For example, in Ialoveni district the rural development level is maximum as both the bathroom and toilet are located in the house.
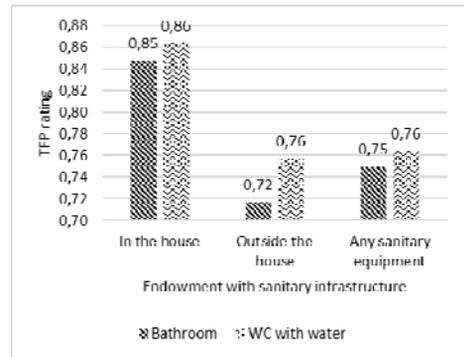

Fig. 5. Evaluation of the rural development level
Source: Own calculation based on data of the survey

However, the minimum value of the TFP rating is attributed to Orhei district: either the sanitary equipment is located outside the house or it is not equipped respectively. This comparative analysis of the sanitary-hygienic performance allows the decision-makers to argue the regional financial investments in this field.
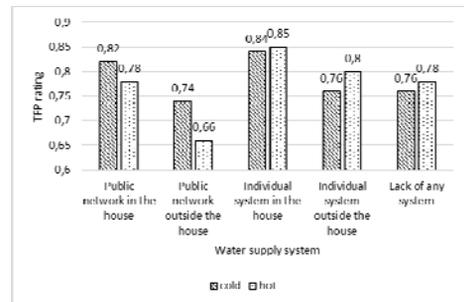

Fig. 6. Comparative analysis of the water supply system in the rural area using the TFP rating
Source: Own calculation based on data of the survey

The water supply system, Figure 6, denotes a high level of sustainable development of the

rural area evaluated through the TFP rating for the households that have the facility located in their own house.

Table 2. Evaluation of the rural development level in terms of endowment with sewerage system

Nr.	Sewerage system	Rating TFP
1	Public network	0.83
2	Individual system	0.77
3	The waters are discharged in the open ditch	0.84
4	No sewerage system	0.77

Source: Own calculation based on data of the survey.

The minimum value R = 0.66 is assigned to the public network located outside the house for the distribution of hot water. An important role in ensuring the ecological comfort of the rural area is the endowment of households with sewage system. Table 2 presents the TFP ratings for the public network option or the wastewater discharge in the open ditch.

Table 3. Evaluation of the rural development level depending on the used home heating system

Nr.	Home heating system	Rating TFP
1	Centralized heating	0.980
2	Individual heating system	0.802
3	Stoves	0.862
4	No heating system	0.598

Source: Own calculation based on data of the survey.

The heating system used in the rural houses represents a significant factor in determining the development level and ensures a sustainable ecological balance. Data presented in Table 3 show that centralized heating has a TFP rating R = 0.980 and represents the common objective of the rural planning. The households that lack heating systems have a lower rating of R = 0.598 and local public administration can be oriented towards the elimination of regional ecological shortcomings.

The efficient energy resources used in the household make it possible to increase the sustainable development in the rural area. Obviously, those consumers who can afford the use of electricity for home heating and cooking process in the kitchen have a major TFP rating according to Table 4. But the liquid fuel (diesel, etc.) has a lower rating R = 0.531 because of the fact that it is not an advanced technology.

Table 4. Evaluation of the rural development level depending on the fuel used in the household

Nr.	Type of used energy resources	Home heating	Cooking in the kitchen
1	Natural gas	0.940	0.854
2	Liquefied gas	0.853	0.773
3	Liquid fuel	0.531	0.858
4	Solid fuel	0.783	0.672
5	Electric energy	0.938	0.893

Source: Own calculation based on data of the survey.

An important role in ensuring the high level of human comfort in the rural area is represented by its access to information and communication facilities. For example, a satellite dish antenna ensures the maximum TFP rating in this field and represents a household welfare index R = 0.870.

Table 5. Evaluation of the rural development level depending on the existing information and communication facilities

Nr.	Information and communication facilities	TFP rating
1	Radio	0.843
2	Television	0.803
3	Fixed-line telephone network	0.811
4	Mobile telephone network	0.828
5	Computer	0.860
6	Satellite dish antenna	0.870
7	Don't have any information and communication facilities	0.722

Source: Own calculation based on data of the survey.

Traditional information and communication technology - radio and television, Table 5, do not ensure the

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sustainable development level of the rural area at average quotas per country and R = 0.803. The nonparametric methodology used for household evaluation shows that the traditional technology used by rural inhabitants (fixed telephone network) does not provide substantial comfort in the rural area and creates a negative trend of population migration towards the urban areas. The use of household appliances is an important factor in assessing the rural development level. Table 6 presents the TFP rating values for various electrical appliances and it is argued that the use of the dishwasher in the household ensures a major human comfort with R = 0.940. The lack of electrical appliances in the household is a dishonorable characteristic of the owner with R = 0.635.

Table 6. Evaluation of the rural development level depending on the degree the houses are equipped electrical appliances

Nr.	Household electrical appliances	TFP rating
1	Refrigerator	0.798
2	Washing machine	0.824
3	Dishwasher	0.940
4	Electric stove	0.849
5	Vacuum cleaner	0.866
6	Microwave oven	0.883
7	No electrical appliances	0.635

Source: Own calculation based on data of the survey.

Also, Table 7, within the research, the impact of the means of transportation owned by the households on the sustainable development level of the rural area was evaluated. It is obvious that a car in the house ensures a high TFP rating and a human comfort level of R = 0.855.

Table 7. Evaluation of the rural development level depending on the endowment with means of transportation

Nr.	Means of transportation	TFP rating
1	Bicycle	0.834
2	Motorcycle	0.796
3	Car	0.855

Source: Own calculation based on data of the survey.

Development of the nonparametric methodology is an important step in the implementation of the techniques for assessing the level of socio-economic development of the rural area and it will help to make recommendations regarding the rural infrastructure development as a way of increasing the living conditions, diversifying the economic activity in the rural areas and creating alternative job opportunities. The results of calculating the TFP rating in rural areas represent a priority of the European agricultural policies, as EU countries provide significant financial means in this regard, including funds for the accomplishment of international scientific projects. Obviously, the values of the rural development level determined for six districts of the Republic of Moldova represent a strong argument in promoting regional policy of the Ministry of Agriculture, Regional Development and Environment.

CONCLUSIONS

The basic objective of the research is to develop a fundamentally new methodology by using the econometric approach to the economic efficiency of rural localities. The possibility of obtaining the primary data on the first and second pillars of sustainable rural development in the Republic of Moldova through multinominal survey to define non-numerical values that involves the use of nonparametric methods of performance evaluation by using software developed by the authors. Taking into account the opportunity of association with the European Union and the fact that the second pillar of the Common Agricultural Policy is an important goal in the European Union's Regional Policy, the selection of survey questions corresponds to the requirements imposed by the European Commission.

General conclusions of the study can be defined as follows:
• the research of the rural area involves the conceptual division of the approach of collecting the primary data by dividing the study object into three distinct parts - social, economic and ecological;

• the information obtained from the survey proved to be excessive in terms of the number of variables that impose difficulties for statistical processing according to the principal components analisys and require a compression of the database content substantially limiting significant factors in the econometric model;

• the list of economic and social indicators in the size of 34 variables was drawn up in order to make the calculation by using the IPAR_TFP software;

• the nonparametric methodology is based on the TFP rating indicator for evaluation the level of the rural area development;

• the agricultural policies of the regional administration in the Republic of Moldova require a comparative analysis of the districts development rating for substantiating the financial support and structuring the subsidies on activity chapters and localities;

• the evaluation of the sustainable development level of the rural area described in the social compartment gives the possibility to optimize the educational and cultural policies in the field;

• the ecological compartment evaluated by the TFP rating gives the possibility to redirect the financial resources within the regional policies of the decision makers;

• the nonparametric methodology proposed for examination in the economic compartment represents a theoretical support to evaluate the efficiency of agricultural technology in the rural areas.

ACKNOWLEDGEMENTS

REFERENCES

[1] Cimpoeș D., Lerman Z., 2006, *Consolidarea terenurilor ca factor pentru dezvoltarea de succes a agriculturii în Moldova.* În: al 96-lea Seminar EAAE Cauze și impacturi ale structurilor agricole. Lucrarea de discuții Nr. 1005. Elveția: The Hebrew University of Jerusalem, p. 36.

[2] Cimpoies D., Lerman, Z., Racul A. 2009, *The Economics of Land Consolidation in Family Farms of Moldova*, EAAE, 111th Seminar, Canterbury, UK, p. 24.

[3] Coelli T., Rao, D. S. P., Battese, G. 2005: *An Introduction to efficiency and productivity analysis*, Kluwer, Boston, p. 349.

[4] Farrell, M.J. 1957: *The measurement of productive efficiency*. Journal of the Royal Statistical Society, Series A, Vol. 120, p. 253-281.

[5] Gorton, M., Davidova, S. 2001: *Farm Productivity and Efficiency in rge CEF Applicant Countries: a synthesis of results. Work Package 5*, Working Paper 2/7. Research Group of Agricultural Economics and Business Management, Imperial College at Wye, University of London, p. 84.

[6] Semionova E., Mitriuc M. *Analiza frontierei stohastice ca metodă de evaluare a nivelului de dezvoltare a gospodăriilor de fermieri în Republica Moldova*, Studia Universitatis Moldaviae, Ed. USM, Chișinău, 2017, p. 125.

[7] Spircu L., Bădin L., et al. 2001, *Eficiență și productivitate. Tehnici de măsurare, software și aplicații economice*. București: Editura economică, p. 208.

[8] Sîrbu A., Cimpoeș D., Racul A., 2016, *Use of date envelopment analysis to measure the performance efficiency of academic departments*. Elsevier, Agriculture and agricultural science procedia, v.10, Amsterdam, Netherlands, p. 578-585.