DETERMINATION OF ACADEMIC PERFORMANCE BY USING THE NONPARAMETRIC METHOD IN THE AGRICULTURAL HIGHER EDUCATION INSTITUTIONS IN ROMANIA AND THE REPUBLIC OF MOLDOVA

DETERMINAREA PERFORMANŢELOR ACADEMICE PRIN METODA NEPARAMETRICĂ ÎN CADRUL INSTITUŢIILE DE ÎNVĂŢĂMÂNT SUPERIOR CU PROFIL AGRAR ÎN ROMÂNIA ŞI REPUBLICA MOLDOVA

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Abstract. *During the process of transition to the market economy, a series of reforms have been undertaken to improve the performance management in the agricultural sector by using the traditional methods of organizing the didactic, research and innovation process. Because the performance evaluation techniques were technically and morally outdated, the impact of the reforms did not reach the goals set. The need to evaluate the performance of the teachers in the institutions of agronomic higher education creates the necessary premises to achieve a match between the requirements imposed on the job occupied with the professional qualities and skills of the one being evaluated. At the same time it is necessary to provide a motivational system as efficient as possible to raise the individual performance level.*
Keywords: *academic performance, agronomic profile, educational policies, higher education institutions*

JEL CLASSIFICATION: C01, C14, I2

1. Introduction.

One of the essential components of the economy of the Republic of Moldova is higher education, which contributes quantitatively and qualitatively to the development and significant growth of the gross domestic product through the training and providing the required amount of the highly qualified specialists. The performance management of the educational institutions is a basic criterion in the comparative analysis of economic competitiveness between countries and creates the intellectual foundation from the perspective of the material evolution of society. Scientific research is the key to success in promoting performance management, both in education and academic structures. In order to promote the implementation of advanced techniques in research and education, econometric methodologies for evaluating the management of academic performance in educational institutions and research subdivisions of the Academy of Sciences of the Republic of Moldova were defined.

The criteria for optimizing the educational process in the institutions with agronomic profile is compulsory to elucidate the problem of scientific research and approach the questions of how, by what means, by what mechanisms and in what period of time it will be possible to achieve a new content in applied scientific research activities. It is necessary to advance on the path from the assimilation and adaptation of some solutions to the scientific research activity, from the

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content itself, in the context of the processes taking place on the European and the world market, to innovation, and to a oriented research activity, framed in an innovation process [2].

The Republic of Moldova, through its educational objectives, has declared itself a country with a market economy and a democratic society with the aims that intersect with scientific research and technological development, a macrostructure of the economy with a series of priorities by branches and fields of activity in the context of medium-short-term objectives. It is argued the need to define what should be applied scientific research, which is its place in the scientific system, for it to lead the process of modernization and restructuring of the economy in its entirety. Within the local university education system, a new structure of scientific research activity must be implemented, which includes aspects regarding the importance of conducting research activities on associated types of activities, technological and innovation progress.

The connection with the structure of the system of scientific research and technological development is particularly important for students in agronomic education. The national research system has inherited research institutions from the centralized economy, and it is necessary to analyze how they fit into the requirements and imperatives of the market economy and the strategy for sustainable development of rural areas. Students' academic performance includes indicators relating to current achievement and promotion in agronomic disciplines and the evaluation of non-parametric rating criteria proposed by the United States researchers. It must be decided which processes need to be encouraged, which of the educational and research institutions inherited from the totalitarian system to be restructured, which need to be reshaped by types and directions of activity and the institutions we need to give up [3].

At the macroeconomic managerial level, the problem is clearly imposed by the need to move from the survival strategy, applied so far, to competitive strategies. However, these strategies must fall within the priority directions outlined. Education and research staff are another aspect of the problem. More than 50% of the collaborators are older than 45 years old and there is no issue in the professional reorientation of this intellectual potential formed in 10-20 years in the conditions of disappearance and restructuring of some activities, of some thematic directions. Educational institutions need young and educated staff in the skilled labor market. Another issue concerns the general reform of the financing of university institutions with agronomic profile, as part of a competitive financing system. In this regard, it is necessary to clearly establish what part of the budget will be used for the development of competitive research mechanisms and what is the share for education. At the same time, it is necessary to abandon the allocation mechanisms, more and more widespread lately, based on the feedback of the ex-ante and ex-post evaluation. Essential support for improving the educational framework and expanding research in line with European trends is achieved through international cooperation.

2. Material and Methods.

Carrying out human resource management reforms in the field of research involves defining a new methodology for evaluating academic performance and selecting new criteria for the classification of unique decision-making units (which can be elements in an educational system) [1].

Investing in the development of human potential is considered the most profitable for the development of a long-term society. Therefore, educational and scientific research institutions must be regarded as strategic units for the country's future. In this context, it is important that the criteria for assessing students' academic performance through the non-parametric method of data envelopment analysis (DEA) be complemented by the idea that the rating of educational institutions shall be determined primarily by the competence and training of people from the academia, their way of working and the ability of institutional structures to effectively exploit this potential.

In order to enter the new horizon of post-industrial civilization, our intention must be to mobilize the potential, the intellectual strength and moral resources of society, the desire to assert itself and the initiative of youth, the education system and other qualities. In other words, it is necessary to improve the legislative framework for promoting reforms in the institutional plan and increasing the quality of agronomic higher education and research. The problem of young researchers (up to 30 years) it is particularly pressing, as they are only 5 percent of the staff. The question remains on how to select, recruit and promote them and to revive this sector of activity. The main concerns that still dominate the education sector are related to technology transfer, to stimulation, evaluation and promotion of economic agents. Complex solutions to these problems can be obtained through the evaluation of both universities with agronomic profile and scientific institutions, but also evaluating the academic performance management of the staff employed in education and research and development. A systematic and comprehensive activity in the field requires a realistic and objective analysis of the current activities.

It is a well-known fact that in modern society, in addition to its role as a promoter of technical-scientific progress, science can also play a key role in the evolution of social processes by promoting performant education. By being more prepared for critical analysis and having a deeper acquaintance of knowledge in the field, agronomists have a common associative vision, through which they can essentially contribute to the consolidation and prosperity of the agricultural sector of the national economy. The development of agricultural enterprises, of their technical and intellectual potential is inconceivable outside the scientific research within it. Scientific research must be oriented towards raising the quality and improving the production technique, widening the range of agricultural products and developing new products depending on the available conditions of the enterprise [6].

The research surveyed a sample of 228 students from four faculties of the University of Agronomic Sciences and Veterinary Medicine, Bucharest (USAMV) in the 2018 academic year. Respectively, the comparative sample of students from the State Agrarian University of Moldova, Chișinău (UASM) includes 334 of respondents spread on different years of study. The evaluation of the academic performance rating was performed with the DEA-UASM software application developed within the Faculty of Economics of the university. The data envelopment analysis methodology uses the distance function as a rating indicator through the variable return to scale option using the main components analysis method. The scientific originality of the academic performance research of university students consists in the inclusion of the linear programming methodology in the hierarchical approach of the organizational principles for three levels: strategic, operational and individual [4].

3. Results and Discussion.

The approaches of academic performance in the samples of university students with agronomic profile are based on the traditional concepts of evaluating competitiveness, efficiency and productivity, Table 1.

Table 1. Academic performance and non-parametric rating of UASM students, Chisinau

	Average Score	Rating
Agronomy	8,43	0,47
Horticulture	8,13	0,39
Veterinary	8,18	0,43
Animal Science	8,00	0,39
Engineering	6,37	0,71
Cadastre	8,38	0,72
Economics	8,06	0,39
Accounting	8,47	0,49

Source: Own calculations based on the survey

The managerial synthesis of this vision underlies the formulation of the econometric model of comparative analysis which includes the functional relationship between the inputs available to the educational system and the outputs that are expressed by the average score of students and the nonparametric rating [7]. The primary data is collected according to the survey defined within the statistics department and includes 24 questions with the multiple-choice answer options in the range of two to six variants.

The comparative analysis of the academic performance of the students for different faculties is presented in Figure 1 by indicating the average score and the DEA rating. Within UASM, the agronomy faculty has a major performance according to the average score, but the non-parametric rating for this faculty is quite low and shows that the complex indicator is more significant, as the statistical sensitivity is more precise. The cadastre faculty, that has a maximum rating r = 0,718, presents a high average score AS = 8,383. This discrepancy is due to subjectivism in the assessment of average score and demonstrates once again that nonparametric evaluation methods are clearly superior as an indicator of performance management and the subjective component is diminished econometrically by the stochastic approach.
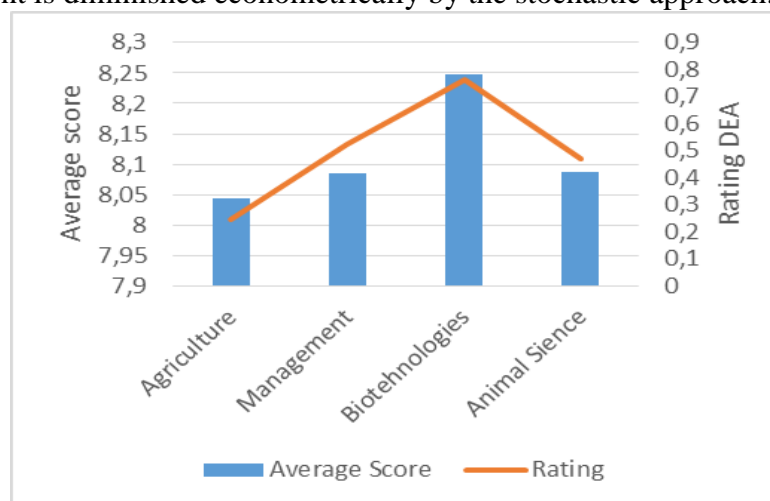

Figure 1. *Academic performance and nonparametric rating of USAMV students, Bucharest*
Source: Own calculations based on the survey

Regarding the comparative analysis of USAMV faculties, it can be firmly stated that for the biotechnology subdivision both the average score AS = 8,247 and the non-parametric rating r = 0,764 show a clearly superior academic performance. In this case, the method of evaluating students contains a limited dose of subjectivism and can be presented as an example to follow. For the management faculty, that has an average score AS = 8,085, the DEA rating presented in Table 2 correlates significantly with the direct evaluation by teachers. The possibility to analyze the nonparametric rating for different subdivisions of the same university, as well as the possibility to compare the values of academic performance within two different universities, shows that the distance function is an appropriate measure of the nature of the educational process.

Table 2. Distribution of academic performance of UASM students depending on the scholarship

	3rd year	4th year	6th year
Score yes	7,96	8,39	8,30
Score no	7,88	7,69	7,93
Rating yes	0,75	0,47	0,39
Rating no	0,66	0,33	0,43

Source: Own calculations based on the survey

As a result of the analysis of the academic performance of UASM students in dependence on scholarship, it can be stated that the option given in the promotion of students is numerically confirmed. For example, the success for different years of study for students who have a scholarship is within 5-50% higher, as the administrative department of the faculties offers scholarships for students who have a higher performance. The current low performance or the presence of negative marks in the current evaluation is charged with the absence of the scholarship. For example, for students in the fourth year of study, the average score of students who have a scholarship is AS=8,39, compared to students who do not have a scholarship, whose average score is AS=7,69. It is a common trend for different faculties that with increasing number of years of study the average score of scholarship students increases and is an element of student self-organization that is promoted through financial investment of the university administration, while students without scholarship, have an almost equal average score in the range of statistical variability.

The comparative analysis of the evaluation of the academic performance of UASM students using the DEA rating, shows a significantly different trend from the average score. The approach to linear programming in performance management includes a complex assessment, so it can be stated with certainty that from the analyzed survey by the main components analysis method, a particular indicator such as average score (or average grade for supporting disciplines according to the study plan) is significantly lower in informative plan against the full non-parametric rating indicator, which is a complex exposition of the 24 survey questions with the nominal distribution according to the Likert scale. Having a negative trend towards the increase of years of study of students with a scholarship from r = 0,75 to r = 0,39, the academic performance shows a decrease in the interest of people in the study process towards professional promotion. Thus, it can be stated that the subjective indicator of the average grade for different disciplines of the curriculum, that depends largely on the personal impression of teachers, has a lower impact for evaluating the educational process in local universities. The major idea within the university administration to award scholarships and student housing accommodation facilities (or other material goods) according to the non-parametric DEA rating is presented in Figure 2. Students who do not have a scholarship have a higher DEA rating than scholarship holders for the year four studies. Thus, the comparative analysis of performance management, is preferable to evaluate students by complex methodology that is not based on the subjective impression of teachers. This is a strong point in defining the methodology for evaluating the academic performance of university students by non-parametric methods, that use as a criterion for determining the integral indicator the distance function as a space metric defined on the inputs.
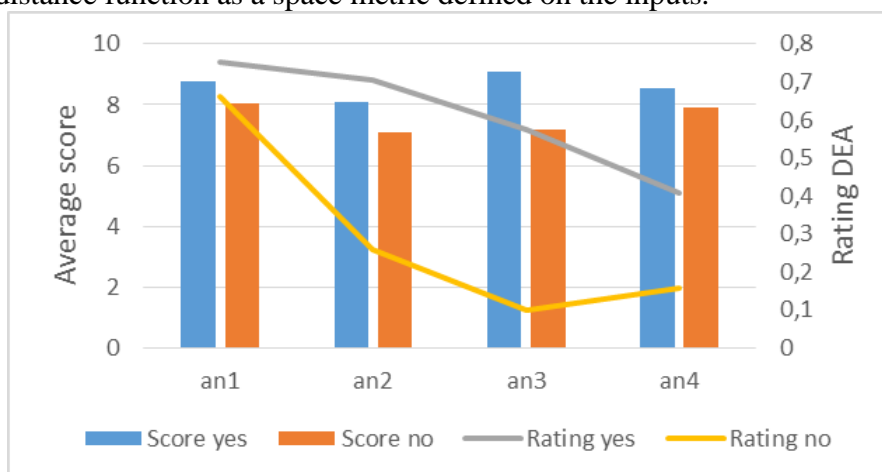

Figure 2. Distribution of academic performance of USAMV, Bucharest students depending on the scholarship
Source: Own calculations based on the survey

As a result of the analysis of the academic performance of USAMV students from Bucharest, the tendency of an increased average score for people who have a scholarship is obvious. For the students of the third year of study, the discrepancy between the presence and the absence of the scholarship represents 20% of the average score for the disciplines taken according to the study plan. The non-parametric DEA rating for the third year of studies also represents a major discrepancy regarding the people receiving the scholarship and represents 83%. This further proves that the subjective assessment of the academic performance of university students is clearly inferior to the complex approach based on the method of the main components analysis of the survey which includes 24 questions with nominal options in the $2 \div 6$ range according to the Likert scale. This is an additional argument in favor of awarding students with scholarships or promoting them through material and non-material incentives according to the non-parametric DEA rating. The academic performance of USAMV students assessed through linear programming is obviously more correct in relation to the fact that for people who have a scholarship, the value of the rating indicator has a negative trend from r = 0,75 to 0,40 with increasing years of study. This reflects the attitude of students towards the educational process more appropriate than the average score that has a growing trend. For students who do not have a scholarship and the interest in the educational process is overshadowed by external reasons, the DEA rating denotes a decreasing trend of hyperbolic type and can be appreciated as a complex indicator of affinity for studies.

Table 3. Distribution of academic performance of USAMV students depending on the participation in student conferences

	AS_yes	AS_no	r_yes	r_no
Agronomy	8,53	8,08	0,43	0,48
Horticulture	8,39	7,83	0,38	0,40
Veterinary	8,79	7,43	0,26	0,57
Animal Science	8,06	7,84	0,46	0,36
Engineering	6,01	7,28	0,76	0,69
Cadastre	8,35	8,50	0,73	0,71
Economics	8,10	7,99	0,46	0,36
Accounting	8,58	8,13	0,58	0,47

Source: Own calculations based on the survey

An important component in promoting the university educational process is the public exposure of research results (scientific activity) of students. The comparative analysis of the academic performance within the faculty carried out by two fundamentally different methodologies gives the possibility to improve the organization of the student scientific conferences and the elaboration of the evaluation criteria in such a way that the subjective factor of administrative, personal or clan influence is diminished. Table 3 presents the evaluation of the performance management of students participating in student scientific conferences within UASM, Chisinau by contrasting the non-parametric DEA approach with the average score. Most faculties achieve a higher average grade for students who attend scientific reports at conferences, and it is an advantage for leaders to guide research in the field by promoting the people who have the best results in the study process. For the Faculty of Veterinary Medicine this discrepancy represents 15% of the average grade and denotes a promotion of eminent students, but the DEA rating shows that conference participants with reports are less successful r = 0,26 compared to students who have a wider spectrum of personal interests according to the results of the survey r = 0,57. The maximum value of the discrepancy between the subjective evaluation of teachers through average score for students who are involved in scientific research and who present reports at the faculty conference as opposed to the linear programming of the results of

the teaching survey has the faculty of animal husbandry with a share of 20% DEA rating. A more contrasting result in the evaluation of academic performance is observed for the Agricultural Engineering Faculty in which the average score of students with scientific reports is 21% lower than students who are not involved in research and involuntarily suggests the preferment of people who have a lower study capacity.

The advantage of non-parametric assessment by the method of linear programming at this faculty is expressed by the higher DEA rating higher r = 0,76 of students conducting scientific research than those who do not report to conferences r = 0,69 with a discrepancy in academic performance of 8,9%. Scientific research in the educational process is a basic pillar in promoting the contingent of students in stages II (master's) and III (doctorate) of the local education system and defining the most appropriate evaluation criteria is a stringent requirement of time.

Consequently, the nonparametric approach proposed in the paper can serve as a useful tool for promoting academic performance as a result of the survey and is certainly not influenced by the subjective contribution of the teacher in the educational institution or administrative shown, as shown in Table 3.
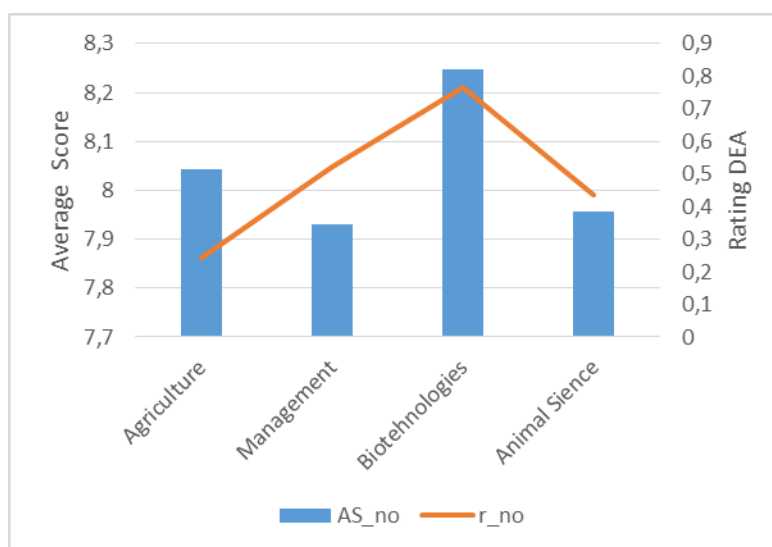

Figure 3. Distribution of academic performance of USAMV students depending on the participation in student conferences
Source: Own calculations based on the survey

The comparative analysis of the academic performance for the students of the USAMV, Bucharest faculties regarding the scientific research is presented in Figure 3. The students of the management faculty have a clearly superior performance in case of participation with scientific reports by 5,8% in case of evaluation through average score. For the Faculty of Animal Husbandry, this indicator has a higher academic performance of 5,1% for students involved in scientific research and has a higher DEA rating r = 0,53 while those who do not report to conferences denote a definitely inferior nonparametric indicator r = 0,43. The conceptual approach in defining the criteria for evaluating scientific promotion in education imposes the need to develop comprehensive markers that are calculated based on the survey and methodologically based on the distance function that represents the space metric defined on the inputs. According to Figure 3, in the agronomy faculty, the students who do not participate in research have a high average grade (and can be challenged by independent assessment), and the nonparametric DEA rating denotes a low academic performance. For the faculty of biotechnology, we can say according to the presented data that the evaluation of the average score correlates to a large extent with the rating evaluated through linear programming [7].

Obviously, there are opportunities for improvement in the econometric argumentation of the proposed methodology for determining performance management, but a broad comparative analysis of students from both universities with an agronomic profile allows to affirm the usefulness of the proposed calculation techniques.

4. Conclusions

In order to adequately evaluate the academic performance of the teaching and research body within the higher education institution and the organizations in the field of science and innovation with agronomic profile, the nonparametric method of the data envelopment analysis of the assigning the DEA_UASM rating was developed. As a result of analyzing the rating of the academic performance in the option of variable returning to scale it is possible to determine the resources for improving the activity of the staff by calculating the distance function for each causal factor.

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