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Dragan Urošević

Zorica Stanimirović

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PREFACE

Mathematical Institute SANU, Faculty of Mathematics in Belgrade and The Yugoslav Society for Applied and Industrial Mathematics (JUPIM) are delighted to host the XLII International Symposium on Operational Research – SYM-OP-IS 2015. SYM-OP-IS has been a national symposium with international participation since 1974. Over past years, the number of international participants was growing, and from this year SYM-OP-IS has officially become an international scientific meeting. It presents an annual gathering of operational researchers in order to exchange scientific and technical information achieved in the development and application of Operations research methods.

The Symposium Programme comprises plenary lectures and theme sections which accommodate the exchange of ideas and the review of relevant issues through valuable encounters of the representatives of the academic body and industry, both from Serbia and abroad.

The main aim of the Symposium is the development and applications of new Operations research methods, models and techniques. We believe that this year program will be interesting as much as in previous years, not only for researchers but also for students and businessmen who are interested in implementation of new solutions based on the methods of operational research in order to improve their business.

Editors:
Nenad Mladenović
Dragan Urošević
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Evaluating the Relative Efficiency of Bank Branches by Using the COOPER-Framework

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Abstract. The aim of the paper is to evaluate the relative efficiency of the branches of Komercijalna Banka AD Skopje in the period between 2009 and 2011 by using the COOPER-framework. In the conducted research the six phases of the framework are being followed. In the first phase (Concepts and objectives) information regarding the profile of the bank branches is gained, and the aims of the empirical study are defined, as well as the aim of using the non-parametric approach DEA. In the second phase (On Structuring data) the inputs and outputs are chosen, and the database is prepared. In the third phase (Operational models) the DEA model is specified, while in the fourth phase (Performance comparison model) the returns to scale and orientation of the model are specified. Since the number of bank branches is small, in regards to the chosen inputs and outputs, it is decided that the DEA technique Window Analysis be used for its growth. Additionally, it is in the fourth phase that the model is solved by using the software tool EMS. In the fifth phase (Evaluation) the obtained results are presented to the bank, and it is concluded that they reflect the real situation. In the last phase (Results and deployment) it is suggested in the bank to use the developed model continuously in order to improve the efficiency of the branches that are identified as relatively inefficient.
Keywords: efficiency, bank branches, COOPER-framework, DEA

1. Introduction

For the purpose of evaluating the efficiency of the branches of one of the leading banks in Macedonia, Komercijalna Banka AD Skopje, this paper utilizes the COOPER-framework, which has been suggested by Emrouznejad & De Witte [3]. Such a framework allows for facilitating the relationship between the stakeholders and the researchers through following its phases and sub-phases, with the aim of not forgetting the issues that are of vital importance in the research. The COOPER-framework consists of six phases: *Concepts and objectives*, *On structuring data*, *Operational models*, *Performance comparison model*, *Evaluation*, and *Results and deployment,* and these phases are interrelated. When the first letter of each phase is taken, it will result in the acronym COOPER (the name of the framework) that is in honor of one of the founders of the leading non-parametric methodology for measuring organizational performance–Data envelopment analysis (DEA). Referring to the evaluation of the performance of the entities, Emrouznejad & De Witte focus on the non-parametric models, or more precisely on the DEA model, but they state that the framework can be adapted to the researcher's needs, and also it can be used for a parametric project. The empirical research conducted in the bank applied the DEA methodology, which was introduced by Charnes, Cooper & Rhodes in 1978 [1]. DEA allows evaluating the relative efficiency of entities that are homogenous (which use the same inputs to produce the same outputs), known as decision making units (DMUs), so that the empirical data are taken for the inputs that are being used and the outputs that are being produced in order to construct the efficiency frontier. Those DMUs that form the frontier are relatively efficient, while the others that are identified as relatively inefficient in order to improve the efficiency and project themselves on the efficiency frontier, the DEA methodology enables the identification of the sources of inefficiency as well as the level of inefficiency of each input, i.e. output. If the sample of DMUs is small in regards to the inputs and outputs that have been chosen, then a larger number of DMUs will form the efficiency frontier, so in order to overcome such a problem the DEA technique Window analysis can be used. By using the Window analysis the number of DMUs increases, and in the analysis of the efficiency of the DMUs the time dimension can be included. In the paper, the DEA Window analysis has been chosen as the most appropriate technique. DEA can be applied to the evaluation of the efficiency of profit and non-profit entities, and one of the most common areas of its application is

banking, more details can be found in [2]. In the reviewed literature there has not yet been found any reference to such an analysis, and this is particularly why it will leave an indelible mark. This paper is organized in the following way: the Introduction, presented in Section 1; the Use of the COOPER-Framework for Evaluating the Efficiency of Bank Branches, presented in detail in Section 2; and the Conclusion, in Section 3.

2. Using the COOPER-Framework for Evaluating the Efficiency of Bank Branches

2.1. First Phase - Concepts and Objectives

The aim of this paper is to evaluate the efficiency of the branches of Komercijalna Banka AD Skopje by using the COOPER-framework. The conducted research in the bank should provide the answer to the following questions: Why is it important for the evaluation of the relative efficiency of the branches to use the COOPER-framework? Can there be noticed any improvement of the efficiency of the bank branches in the observed period? Komercijalna Banka AD Skopje has 11 branches (Ohrid, Prilep, Strumica, Kochani, Veles, Shtip, Kumanovo, Kavadarci, Gostivar, Bitola, and Tetovo), so in order to come to information regarding their profile, an interview was conducted with the Chief Operative Officer of the bank and the Manager of the Independent Branch Network Management Department. From the given eleven branches, the first eight perform the same financial activities in the observed period (2009-2011) and they in fact present the sample of analysis, while the branches Gostivar, Bitola, and Tetovo, which started work in 2010, are exempt from the analysis. Evaluating the relative efficiency of the bank branches has been done with the non-parametric methodology DEA. If the efficiency in the banking sector is to be measured, the following approaches can be employed: production (operational), intermediation, and the profitability approach. In this paper, emphasis is placed on the intermediation approach.[1] "The *intermediation approach* captures the process in which deposits are being converted into loans" [5, p. 355]. In the first phase of the COOPER-framework the aims of the empirical research are defined, and they are: to identify the inputs and outputs for the intermediation approach; to assess the importance of the identified inputs and outputs; to develop a suitable DEA model; and to identify the relatively efficient and relatively inefficient branches. Since this is the first research in Macedonia which employs the COOPER-framework and DEA methodology, in order to evaluate the relative efficiency of the branches of one bank, a meeting was held with the employees of the Independent Branch Network Management Department, during which they were introduced to the framework phases and the basics of DEA.

2.2. Second Phase - On Structuring Data

In order for the bank branches to be evaluated, it is necessary to identify the inputs and outputs. According to Emrouznejad & De Witte [3], the inputs and outputs can be justified through: the existing literature; managerial analysis (choosing inputs and outputs that according to the entities are thought to be the best); multivariate analysis, or ratio analysis. For determining the approach that would be used for the choice of inputs and outputs, an interview was conducted with the Manager of the Independent Branch Network Management Department, and it was decided to use managerial analysis. A list of inputs and outputs was created, on the basis of which a questionnaire was hence created,[2] and it was distributed to the managers of the 11 bank branches. The participants were asked to assess the importance of the inputs and outputs, by using a scale of 1 to 5 (1 signifying "the least importance", and 5 signifying "the greatest importance"). The participants could assign the same grade for different inputs (or outputs), and if they thought the questionnaire did not contain an important input (or output), then they could add it and assess its importance. The first part of the questionnaire regarded the general socio-demographic data, while the following part included assessing the importance of the inputs and outputs. The last question in the questionnaire was of an open type, and referred to participants' suggestions and comments. The questionnaire was sent to the participants by email, and every participant sent back the filled-in questionnaire by email. Out of 11 participants, 8 (73%) were males, while 3 (27%) were females. Regarding their age, 45% were of the age up to 50 years, while 55% were

[1] For evaluating the efficiency of the branches of Komercijalna Banka AD Skopje, when the profitability approach is used, see [10].

[2] For the creation of the questionnaire it was used the experience of Begicevic [6, p. XI – XIV].

over 50 years of age. In addition, regarding their level of education, all of the participants had a university education. Every participant had assessed the importance of the inputs and outputs; no one had added other inputs and outputs; and there were no additional suggestions or comments. On the basis of the collected data from the questionnaires on the inputs and outputs of the intermediation approach, the measure of central tendency– mean was calculated for each input and output, and it was used for the choice of inputs and outputs. Variables for two DEA models were chosen, and in this paper one model is presented. As inputs were chosen: deposits structure and operational costs (salary costs and material costs), while as outputs were chosen: corporate lending and lending to citizens. After collecting the data for the chosen inputs and outputs, it is of great significance to analyze whether there is missing data for any input (output), and whether there are negative values or values that equal to zero. Analyzing the collected data on inputs and outputs, it was determined that the value of the variable corporate lending is 0 for branch 8 in the first year of the observed period, while for all of the other variables the values are higher than 0. In this phase the final database was prepared in order to run the model. The data for the inputs and outputs were collected for the first time for the purpose of the research, and since they are not available to the public, they could not be published in the paper. The real names of the branch are replaced with the numbers.

2.3. Third Phase - Operational Models

There are two main categories of the models: parametric and non-parametric. The parametric models present an *a priori* specification on the production function, while the non-parametric models do not require any *a priori* specification on the production function. In this phase of the COOPER-framework, the category of non-parametric models is specified, from it, the variant deterministic model is chosen, and then data envelopment analysis is selected. For the parametric models see [11].

2.4. Fourth Phase -Performance Comparison Model

In the fourth phase, it is necessary to re-analyze the chosen inputs and outputs of the model, so as to determine whether they are the most appropriate, but starting from the way they were chosen, it was decided to use the selected variables. Additionally, the variable returns to scale (VRS) and the output-orientation of the model were specified. Variable returns to scale means that the proportional increase of the inputs does not lead to a proportional increase of the outputs [8], while the output-oriented model has the aim of maximizing the outputs at a given level of inputs [12]. The envelopment form of the output-oriented Banker-Charnes-Cooper DEA model is presented in [9, p. 79]. Since the number of branches is small in regards to the chosen inputs and outputs (details about the number of DMUs can be found in [12, p. 116]), and the data is collected over a period of three years, in order to evaluate the relative efficiency of the bank branches, in this phase the DEA technique Window analysis is chosen. When this technique is used, each decision-making unit in a different period is observed as if it were a "different" decision-making unit, but it remains comparable in the framework of the same window [4, p. 6]. The sample consists of 8 branches (n=8), 3 years are taken into consideration (2009, 2010 and 2011) (k=3), the length of the window is 2 years (p=2), the number of windows is 2 (w=2), in each window the number of branches is 16 (= np = 8×2=16), and the number of "different" branches is 32 (=npw=8×2×2=32). Each window covers 2 years, and they are shown below:

window 1	2009	2010	
window 2		2010	2011

The software tool EMS 1.3 is used for solving the output-oriented DEA Window analysis model with VRS assumption, more details about this tool can be found in [7].

2.5. Fifth Phase – Evaluation

The obtained results (Table 1) were presented to the Manager of the Independent Branch Network Management Department and the Department's employees, and it was determined that they correspond with the real situation. If the efficiency result of the branch is 100%, then it is relatively efficient, otherwise, a result higher than 100% means that it is relatively inefficient. In 2009, branch 8 could not be compared to the other branches because the output corporate lending had a value zero. From Table 1 it can be noticed that only one branch (branch 6) is efficient for each year in each window, while branch 7 is identified as the least efficient in the whole observed period. Two branches (1 and 7) had improved their efficiency between 2009 and 2010.

DMUs	Efficiency results (%)			Overall efficiency	
	2009	2010	2011	by windows	by years
B1	103.63	100.00 100.00	115.86	104.87	106.50
B2	104.80	114.12 113.15	151.80	120.97	123.41
B3	100.00	109.86 100.00	116.86	106.68	107.26
B4	100.00	176.02 174.91	200.42	162.84	158.63
B5	100.00	100.82 100.00	100.00	100.21	100.14
B6	100.00	100.00 100.00	100.00	100.00	100.00
B7	215.46	203.12 194.86	201.29	203.68	205.25
B8	100.00	100.00 100.00	144.89	111.22	114.96

Table 1. Efficiency results

2.6. Sixth Phase - Results and Deployment

In the last phase of the COOPER-framework, the obtained results were presented and interpreted to the Chief Operative Officer of the bank, who confirmed as well that they reflect the real situation. In addition, for continuous improvement of the branches' efficiency, it has been suggested that the developed model be further used in the bank.

3. Conclusion

The aim of this paper was to evaluate the efficiency of the branches of Komercijalna Banka AD Skopje by using a standardized framework, namely the COOPER-framework. The success of the conducted research in the bank depended especially on following the framework's phases and sub-phases (which had been adapted to the needs of the research), as well as on the cooperation of the researcher with the bank's management. For the purpose of evaluating the efficiency of the branches, the DEA Window analysis was applied, and it was determined that the obtained results reflect the real situation. One branch was identified as being relatively efficient for each year in each window, while two branches had improved their efficiency between 2009 and 2010. By using this framework it is not only facilitated the cooperation between the researcher and the stakeholders, but also it is allowed the non-parametric evaluations to be more reliable. Also, a continuous application of the developed model has been suggested in the bank so that the inefficient branches can improve their efficiency.

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