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Assessing Efficiency In Banking

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Summary:
The paper is an attempt to assess the productivity and efficiency on the basis of the information found in financial statements and operating evidence, as well as implementation of the DEA method. The definition of both input and output in banking is absolutely clear, however, an adequate analysis of efficiency in banking requires that the right combinations of input and output be selected Every company has its own principles to implement in its operations. One of the most important is surely the efficiency principle. Relevant academic literature offers various combinations of input and output in testing bank efficiency. The developing countries will find it highly important to monitor bank efficiency and compare it to the countries in the region.

Key words:
bank productivity, efficiency, management, financial information, the DEA method

Rezime:
Akcenat u ovom radu je na merenju produktivnosti i efikasnosti na osnovu informacija iz finansijskih izveštaja i operativnih evidencija, kao i primena DEA metode. Opšte je poznato šta je input a šta output kod poslovanja banaka, ali je za adekvatnu analizu efikasnosti rada banaka bitno odabrati prave kombinacije inputa i outputa banke. Svaka kompanija ima svoje principe koje primenjuje u svom poslovanju. Svakako jedan od najvažnijih principa je princip efikasnosti U relavantnoj akademskoj literaturi se mogu videti razne kombinacije inputa i outputa u testiranju efikasnosti rada banaka. Za zemlje u razvoju posebno je važno da se prati efikasnost banaka i upoređuje sa zemljama u regionu.

Ključne reči:
DEA metod, efikasnost, finansijske informacije, menadžment, produktivnost banaka

1. INTRODUCTION

The fact is that the share of labour costs in the total bank expenses is rather large, therefore it is very important that the bank personnel productivity should be assessed. Due to the specific nature of banking services, however, it is very difficult to define a quantitative measure of the results achieved per unit of work input for a period under study.

To analyse the productivity, economy of operations and profitability means to study three forms of business efficiency, and these are:

- Technical efficiency or *productivity* that is a ratio between the quantities produced, i.e., items of products or services and the factors of production (employees, working hours, assets);
- Economic efficiency of *economy of operations* that is an expence to income ratio; and
- Financial efficiency or *profitability* which is a return on assets ratio.

Productivity is expressed in natural (quantity) unity, whereas economy and profitability are expressed in the value (monetary) units of measure. Generally speaking, the *efficiency principle* is present if higher economic effects of output value are achieved with as small as possible economic input. According to the classic economic theory, efficiency is measured as a quotient of one output and one input (See - [5]). In practice, business entities dispose of a variety of input values, as well as of a large number of output values. The problem arises if no common expression is found for them.

The factors that affect the business efficiency may be exogenous (*nature* – climate, meteorological and national character; *society* – state, unions; *market* – favourable market trends) and endogenous (*objective* – organization, size and position of bank on the market, and *subjective* – ability to achieve good banking performance). Besides, the factors affecting economy in operations can be classed as internal (bank location, bank capacity, IT equipment, bank managers' expertise and business competences) and external (clients, purchasing power, number of competitor-banks, financial capacity of competitors). Economy of operations is understood as the total expense to income ratio, or as a partial indicator, e.g., the ratio between business income and business expenses.

2. PRODUCTIVITY MANAGEMENT IN BANKS

Directly responsible for a high quality of banking service is the bank personnel, since they come into direct contact with the clients. In order that a high level of banking service quality be achieved it is important that communicative abilities of bank personnel in providing banking services should be developed. Furthermore, it is necessary that the bank employees should be delegated an adequate level of authority so that they should be motivated to provide a highest quality service, which in turn results in customer satisfaction, on one hand, and may have favourable implications upon the performance of employees, on the other.

To improve the bank productivity needs that a plan of measures to be devised, that is one of the plans to improve the strategic position of the bank. Having in mind the specific nature of the banking business, it is necessary that measures should be anticipated in the following segments (Figure 1.):

a) Organization of work (adequate job classification);
b) Research into the opportunities to implement information and communication technologies;
c) Improving the qualification level of bank personnel (investment into employee education and training);
d) Identifying an adequate employee monitoring and rewarding system.

An efficient bank productivity management entails monitoring productivity in three segments:

- As regards planned values;
- As regards the performance of similar banks within the banking branch;
- Benchmarking in view of the leader of the branch to which this particular bank belongs.

It is important to stress the necessity that the average productivity is closely monitored and interpreted in any branch. Namely, it is necessary that productivity trend is compared to that of the number of employees. The growth in productivity is significant when it serves as an indicator of sustainable and expansive growth in the period of development. The employee productivity analysis should also include the analysis of the gross domestic product, as well as expenses for the gross and net earnings of employees. An efficient productivity management requires that a system to stimulate motivation of bank personnel be identified.

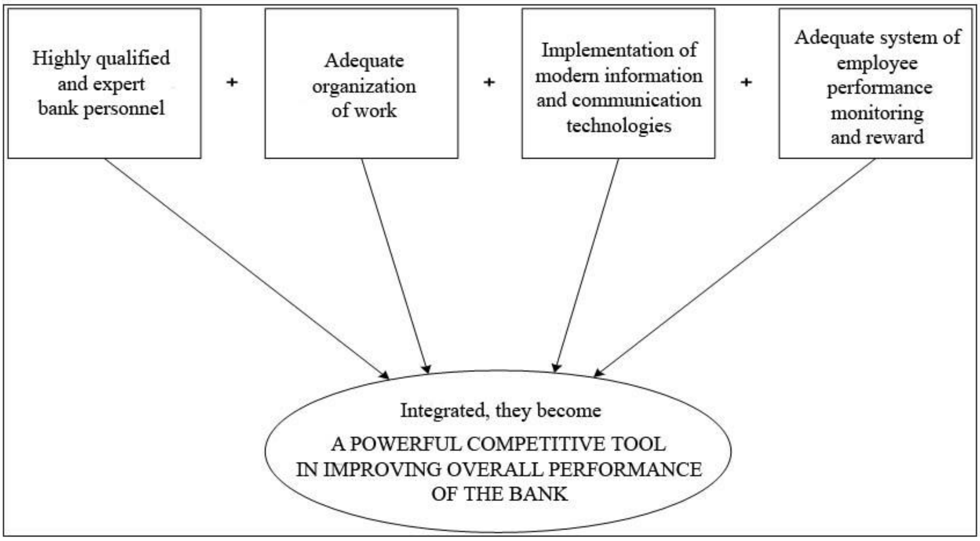

Figure 1. Tools to improve productivity

Hereinafter a list of financial coefficients that can be used in measuring work productivity in banks is presented:

Table 1. Productivity indicators in RSD

Productivity indicators	**Numerator**	**Denominator**
Productivity of employees in the bank (per employee)	Net operating income	Number of full time employees in the bank
Productivity per operating unit	Net income	Number of organizational units in the bank
Expense to income ratio	Bank operating income	Employee earnings expenses (gross earnings/coefficient 1.62)
Assets per employee	Assets	Number of full time employees in the bank
Productivity of all employees in the bank	Total income	Total number of employees in the bank

Productivity per effective working hours	Total income	Number of effective working hours
Productivity per number of signed contracts in the organizational unit	Average earnings per employee in the organizational unit under study (branch office, affiliate)	Number of contracts signed
Ratio between the number of open accounts and the number of employees in the organizational unit	Number of open accounts	Number of employees in an organizational unit
Ratio between the state on the clients' accounts and the number of employees in the organizational unit	Total amount on the clients' accounts	Number of employees in an organizational unit
Ratio between net interest margin of the bank and the employees of the bank	Net interest margin of the bank	Total number of employees in the bank
Ratio between earnings and working hours	Total income	Number of total working hours
Ratio between net interest margin of the branch office and the employees of the branch office	Net interest margin on the level of organizational unit – branch office	Total number of employees in the branch office
Bank operations costs per employee ratio	Bank's operating expenses	Total number of employees in the bank
Ratio between the number of loan contracts signed and number of employees	Total number of loan contracts signed	Number of employees in the credit department
Ratio of the number of reasonable claims of clients of the organizational unit and the number of employees in it	Total number of reasonable claims of clients of the organizational unit (branch office or affiliate)	Number of employees in an organizational unit (branch office or affiliate)
Organizational unit marginal result and the number of employees ratio	Marginal performance of organizational unit - branch office	Total number of employees in the branch office
Organizational unit marginal result and the number of working hours ratio	Marginal performance of organizational unit - branch office	Number of effective working hours in the bank
Ratio between net income from interests, compensations and commissions of the bank and the number of employees in the bank	Net income from interests and net income from compensations and commissions on the bank level	Total number of employees in the bank
Ratio between income before tax and the total number of employees	Profit before tax	Total number of employees in the bank
Ratio between net operating profit of the bank and the total number of employees of the bank	Bank's net operating profit (net income from interests, compensations and commissions and other net income)	Total number of employees in the bank
Ratio between a relative chanfe in total income of the bank and the relative change in the number of employees in the bank	Percentage of change in the bank's total income	Percentage of change in the total number of employees in the bank

Productivity is expressed in natural (quantitative) units, and economy of operations and profitability are expressed in the units of value. There is a difference between the productivity of work and the productivity of a company.

3. MEASURING PRODUCTIVITY IN BANKS

In simple words, efficiency means success and indicates the level of performance of companies that have certain inputs (deposits, loans granted, assets employed, property and other) into production or services for the purpose of achieving certain outputs, e.g., income, profits, etc.

The partial efficiency of *i* – company is defined as follows:

$$PE_i = Partial \quad efficiency = \frac{output}{input}$$

This efficiency definition is predominantly used by financial analysts to measure productivity, economy of operations, profitability etc. The ratio coefficients are well known and easily implemented to measure business efficiency, however they show efficiency partially (A more detailed critical account on the ratio analysis implementation see - [7]). This is a parametre approach to efficiency measures.

O'Donnel (2008) (For more details on technical and allocational efficiency of 43 Chinese banks for the period 1993-2000, see- [3]) defines the total efficiency factor (TE) as a ratio of any PR with a maximum value PE and *n* companies observed:

$$TE_i = \frac{PE_i}{\max PE_i}$$

Productivity can be measured as a quotient of one output and one input; then the obtained indices are divided from one period to another. For example, if averages of total incomes per employee are calculated and if these averages are divided with the previous average income per employee, the productivity index is obtained. Averages per employee can also be studied per certain segments:

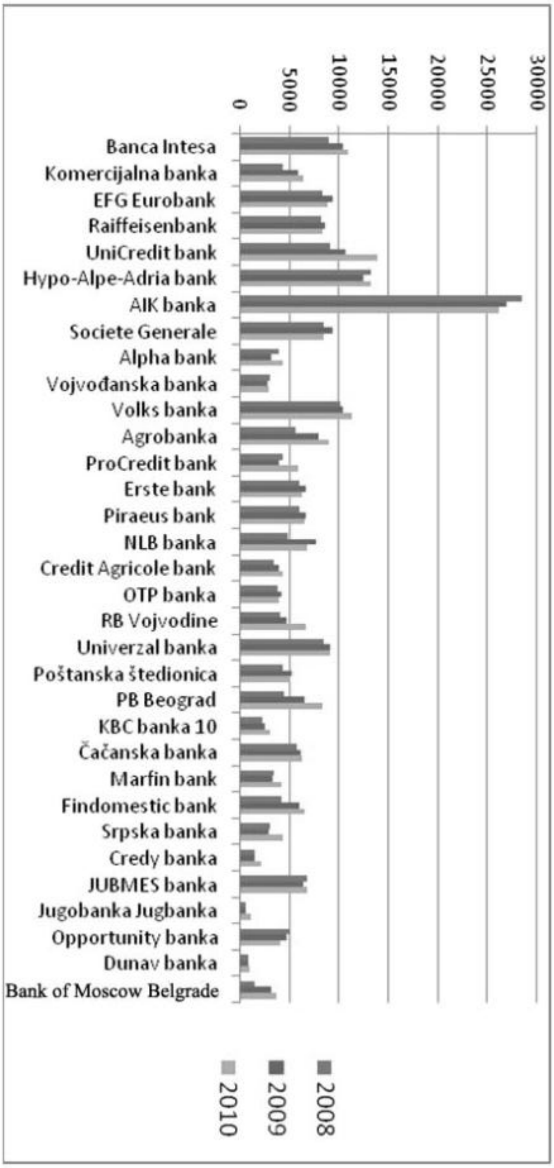

Figure 2. Average total incomes per employee in 2008., 2009. and 2010., per banks – Serbian market

In addition to the average total income per employee, certain other values should be observed, such as balance sheet assets, net interest margins, deposits, credits and operations expenses per employee to get a clearer picture on the productivity of the banking sector as a whole, as well as of the productivity of individual banks.

If we observe the total income in relation to the number of employees for the years 2008, 2009 and 2010, we obtain partial productivity indices (Table 2.).

Table 2. Productivity indices and geometric growth rates

	Productivity index		Geometric growth rate of		
	2009/2008	2010/2009	total income	number of employees	Productivity
Banca Intesa	**104.22%**	**115.70%**	**110.68%**	**100.79%**	**109.81%**
Komercijalna banka	108.17%	136.09%	119.33%	98.35%	121.33%
EFG Eurobank	94.35%	113.08%	101.71%	98.46%	103.29%
Raiffeisenbank	96.09%	105.57%	95.67%	94.99%	100.72%
UniCredit bank	130.53%	116.06%	124.74%	101.35%	123.08%
Hypo-Alpe-Adria bank	106.98%	93.31%	98.70%	98.79%	99.91%
AIK banka	**97.11%**	**94.82%**	**99.53%**	**103.73%**	**95.96%**
Societe Generale	90.15%	110.77%	104.24%	104.31%	99.93%
Alpha bank	135.23%	**81.21%**	99.89%	95.32%	104.79%
Vojvođanska banka	101.36%	92.77%	93.00%	95.91%	96.97%
Volks banka	108.69%	102.86%	103.29%	97.69%	105.73%
Agrobanka	113.58%	138.53%	124.94%	99.60%	125.44%
ProCredit bank	148.10%	91.43%	101.63%	87.34%	116.37%
Erste bank	94.93%	111.05%	102.06%	99.40%	102.67%
Piraeus bank	98.80%	109.47%	101.90%	97.99%	104.00%
NLB banka	87.71%	156.21%	98.95%	84.53%	117.05%
Credit Agricole bank	108.05%	117.92%	110.29%	97.71%	112.87%
OTP banka	94.43%	108.75%	**79.88%**	**78.83%**	101.34%
RB Vojvodine	142.72%	114.09%	130.68%	102.41%	127.61%
Univerzal banka	99.17%	108.30%	105.88%	102.17%	103.64%

Poštanska štedionica	98.20%	122.54%	117.92%	107.50%	109.69%
PB Beograd	126.13%	144.33%	138.48%	102.63%	134.92%
KBC banka 10	118.72%	108.05%	111.98%	98.87%	113.26%
Čačanska banka	102.79%	106.23%	103.43%	98.99%	104.49%
Marfin bank	125.87%	98.12%	111.98%	100.77%	111.13%
Findomestic bank	109.69%	142.58%	116.59%	93.23%	125.06%
Srpska banka	146.45%	94.10%	118.92%	101.30%	117.39%
Credy banka	135.33%	101.92%	94.22%	80.22%	117.44%
JUBMES banka	106.15%	94.14%	101.25%	101.28%	99.97%
Jugobanka Jugbanka	**160.90%**	108.26%	136.37%	103.32%	131.98%
Opportunity banka	**84.27%**	96.52%	120.10%	**133.16%**	90.19%
Dunav banka	119.94%	95.71%	130.98%	122.24%	107.14%
Bank of Moscow Belgrade	115.82%	**216.27%**	**176.52%**	111.53%	158.27%
MAX.	160.90%	216.27%	176.52%	133.16%	158.27%
MIN.	84.27%	81.21%	79.88%	78.83%	90.19%

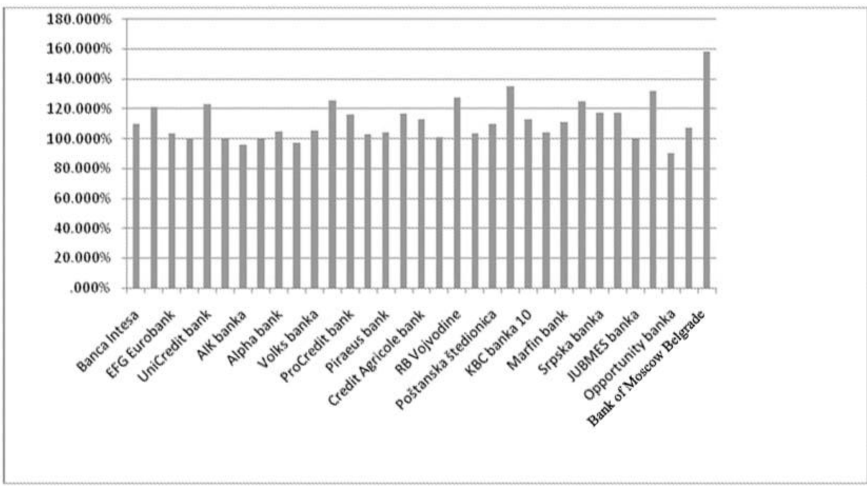

Figure 3. Geometric productivity rates per banks in Serbia for the period 2008.-2010.

The productivity indices changed from period to period for two reasons, due to the increase in the number of employees or the decrease in the number of employees, or due to the increase or fall in the total income. The above Figure 3 offers a good illustration of these changes. For example, the largest reduction in productivity was recorded in the Opportunity bank in 2009 as compared to 2008, as well as the Alpha bank in 2010 as related to 2009. On the other hand, the highest rise in productivity was recorded by the JugoBanka, 160.90% (2009/2008) due to the increase in real income, as the number of employees remained unchanged. The Bank of Moscow Belgrade experienced a similar situation of rise in productivity by 216.27% in 2010 as compared to 2009 due to an average yearly 76.52% rise in total income.

Geometric growth rates of total income and the number of employees in 2008, 2009, and 2010 show an average rise (above 100) and average fall (below 100) from year to year, successively. The interpretation of geometric growth rate helps understand and interpret the productivity indices. The geometric growth rate of productivity is highest in case of the Bank of Moscow Belgrade and lowest in the Opportunity Bank on average (90.19%). The Opportunity Bank and the Bank of Moscow were below the efficiency lower limit for the years observed.

4. BACKGROUND INFORMATION ON THE DEA METHOD

The DEA (*Data Envelopment Analysis*), i.e., the analysis of data envelopment is a specially defined procedure implemented in assessing the efficiency of complex business system units with varied inputs and outputs (see - [9]). DEA is an old method. It has been in use for over 30 years and, with the development of computer softwares, has come to be central when it comes to assessing the efficiency of business units. The DMU (*Decision Making Unit*) is a standard term for business units included in the unit efficiency analysis on the basis of selected input and output values. The DEA provides the results on the DMU in view of either efficiency or inefficiency, as well as shows how much a certain input has to be reduced and/or how much a certain output has to be increased so that a certain DMU should become efficient. The DEA method has a large number of unit efficiency analysis models (see - [4] and [5]), as well as models for productivity analysis, tracking and analysis of the efficiency dynamics over time, ranking the entities under study, etc. The so-called DEA *Window* analysis and the Malmquist DEA index analysis have been developed for the purpose of the analysis of the efficiency dynamics of production technology and DMU productivity over time. Each model of analysis has its assumptions that have to be satisfied in order that the results should be valid and applicable.

The implementation of the DEA method goes through certain phases, each with its own assumptions. Firstly, the input/output values have to be higher than or equal to zero. Secondly, the *property of isitonosity* means that the increase in an input causes the increase in an output without reducing any other input. The property of isitonosity can be proved through a correlation analysis of the given inputs and outputs. The minimum number of DMUs is 3 and, according to literature, the number of DMUs should be larger than the total number of inputs and outputs, since it is the aim of the DEA to present every DMU as efficient as possible. The *weighting factors* developed by the DEA method serve the stated purpose, i.e., try to present every DMU as efficient as possible in comparison with the other DMU in the set of units under study. Some restrictions to weights, however, can be introduced. Thirdly, the assumption of *homogeneity* of the DEA method for the DMU means that the set of DEMs is *relatively homogenous* when the units it includes are uniform (similar), i.e., when they share at least one common feature. The larger the number of their common features, the more homogenous the set. Besides, the set of DMUs should be differentiated and complete. The DMU set is *differentiated* when the units under study are uniform, but not identical. The aim of the analysis is to test the differentiation and quantify the efficiency of DMUs included in the set. The set of DMUs is *complete* if it includes all individual cases of the phenomenon under study in time and in space.

Theoretically, a large number of DEA models have been developed and they can be solved using the appropriate software. The DEA methods are based on solving the linear programming tasks (see - [3]). Traditionally, banks implement various profitability measures to evaluate their performance. Usually a number of indicators are selected that are focused upon different aspects of business transactions. The ratio analysis, however, provides a relatively insignificant quantity of information when observing the effects of the economy of scope, identification of *benchmarking* policies and when assessing the overall bank performance measures. The alternative to the bank's traditional tools in bank efficiency management are the DEA frontier analyses that allow for the management to objectively identify the best practices in the complex environment in which banks operate (see - [9]). The DEA ensures a comprehensive analysis of relative efficiencies for the defined inputs and outputs, i.e., input and output parametres.

The first approach, the efficiency of one DMU is defined as a one input/one output ratio and shows a partial efficiency of the DMU, which has already been dealt with in this paper (Table 1). This is a parametric test.

The other approach is non-parametric. It starts from the fact that assessing the efficiency of a unit, especially a non-profit one, requires that a larger number of inputs and outputs should be analysed; they differ in nature (financial, technical, social, etc.) and are expressed in different units of measure. In such cases a conclusion on the efficiency level cannot be drawn on the basis of partial indicators of efficiency that assess the efficiency of individual elements of the unit. Accordingly, it is necessary that a sum synthetic unit efficiency indicator should be defined that will take into consideration all the significant input and output elements as a whole used in the realization of these. The formula for the DEA efficiency implementation is the following:

$$\text{DEA } \mathit{Efficiency} = \frac{\text{Weighted synthetic output}}{\text{Weighted synthetic input}}$$

The DEA method assesses each DMU as relatively efficient or relatively inefficient.

Charnes, Cooper and *Rhodes* (1978) (see -[2]) maintain that a DMU can be determined as *efficient* only on condition the following conditions are not met:

- Any output can be increased without an increase in any of the inputs and without a decrease in any other output;
- Any input can be reduced without a decrease in any of the outputs and without an increase in any other inputs.

For each inefficient DMU, the DEA method identifies the level and contents of inefficiency for each input and output. This level of inefficiency is defined by comparison with one referent DMU or with a convex combination of other referent DMUs that are on the border of efficiency and that use the proportionally same input level and produce a proportionaly same or higher output level.

The models of the DEA method differ depending on the approach to the input and output analysis. The economic interpretations of the results of the models also differ in accordance with the approach and they can further be used by managers to manage both efficient and inefficient units.

Basic models of DEA method

MODEL D1. Let x_{ij} – be the observed value of *i*-type input for DMU_j (x_{ij} > 0, *i* = 1,2,...,*m*, *j* = 1,2,...,*n*), and let y_{rj} – be the observed value of *r*-type value for DMU_j (y_{rj} > 0, *r* = 1,2,...,s, *j* = 1,2,..., n).

Charnes, Cooper and Rhodes (see - - [2]), proposed (known as the CCR ratio model) that an optimization task of the following form should be solved for each DMU_k, *k* = 1,2,...,*n*:

$$\max h_k(u,v) = \sum_{r=1}^{s} u_r y_{rk} / \sum_{i=1}^{m} v_i x_{ik}$$

on conditions that:

$$\sum_{r=1}^{s} u_r y_{rk} / \sum_{i=1}^{m} v_i x_{ik} \leq 1, u_r \geq 0, v_i \geq 0, \text{ r = 1,2,...,s, j = 1,2,...,m,}$$

where h_k is a relative efficiency of k-DMU, n – the number of DMUs under study, m – the number of inputs, and s – the number of outputs, u_r is a weighted coefficient for the output *r*, while v_i is a weighed coefficient for the input *i*. The weighted coefficients u_r and v_i are the unknown values in the model that are defined through optimization and construct a virtual input and a virtual output.

On the basis of the abovementioned a conclusion can be drawn that $0 \leq h_k \leq 1$.

- If h_k equals 1, the *k*-DMU is relatively efficient. That means that no other DMU can achieve a higher value of output for the given input. An efficient k-DMU shows optimum values for weighted coefficients.
- If h_k is below 1, the *k*-DMU is relatively inefficient and the value of h_k shows by what percentage the *k*-unit should reduce its inputs.

The weighted coefficients u_r and v_i show the extent to which each input and output are important for each DMU so that each DMU should be as efficient as possible.

This model is non-linear, non-convex, with a linear function of goal and restraints.

MODEL D2. Model D1 can be reduced to a linear model in the following manner:

(A)
$$\max z = \sum_{r=1}^{s} u_r y_{rk} ,$$

on conditions that:

$$\sum_{i=1}^{m} v_i x_{ik} = 1, u_r \geq 0, v_i \geq 0, \quad \sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ik} \leq 0 , j = 1,2, \ldots, n.$$

$u_r \geq \varepsilon, v_i \geq \varepsilon$, where ε is a small positive value, i.e., $\varepsilon > 0$, r = 1,2,...,s, j = 1,2,...,m. Model D2 maximizes the virtual output on condition that its virtual input equals 1. A dual problem of linear programming for model (A) is

(B)
$$\theta^* = \min \theta ,$$

on conditions that:

$$\sum_{j=1}^{n} \lambda_j x_{ij} \leq \theta x_{ik} , i = 1,2,\ldots, m ,$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} \geq y_{rk} , r = 1,2,\ldots, s , \ \lambda_j \geq 0, \ j = 1,2,\ldots, n .$$

MODEL D3. The dual CCR DEA model with supplementary variables is

$$\theta^* = \min \theta - \varepsilon \left(\sum_{r=1}^{s} s_r^+ + \sum_{i=1}^{m} s_i^- \right)$$

on conditions that.

$$\sum_{j=1}^{n} \lambda_j y_{rj} - s_r^+ = y_{rk}, r = 1,2,\ldots, s$$

$$\sum_{j=1}^{n} \lambda_j x_{ij} + s_i^- = \theta x_{ik}, i = 1,2,\ldots, m$$

$$\lambda_j, s_i^-, s_r^+ \geq 0, \quad za \quad \forall i, j, r.$$

Dual variables s_i^- *and* s_r^+ show the extent to which it is possible for the k-DMU to individually reduce the i- input and increase the r- output in order to become efficient. The parametre λ_j is a dual weight and shows the value assigned to the j-DMU in defining the balance between input and output values.

Definition of DEA efficiency: The performance of DMU_k is weakly efficient and only on condition that $\theta^* = 1$ and all the poor $s_i^{-*} = 0, s_r^{+*} = 0$.

Definition of weak DEA efficiency: the performance of DMU_k is weakly efficient and only on condition that $s_i^{-*} \neq 0$ *and/or* $s_r^{+*} \neq 0$ or for an *i* or *r* are in a certain optimum.

The Table 3 below presents CCR DEA models, input and output oriented versions, as well as a dual problem of linear programming.

These are well known CRS models since constant returns to scale are assumed (Constant Return to Scale Model). With an additional condition that $\sum_{j=1}^{n} \lambda_j = 1$, models are obtained known as BCC DEA models (see - [1]), i.e., VRS (the Variable Returns to Scale Model), is accordance with the literature used.

Table 3. CCR DEA Models

Input orientation	
Envelopment model	Multiplicative model
$\theta^{*} = \min\ \theta - \varepsilon\left(\sum_{r=1}^{s} s_r^{+} + \sum_{i=1}^{m} s_i^{-}\right)$. on conditions that $\sum_{j=1}^{n} \lambda_j y_{rj} - s_r^{+} = y_{rk}, r = 1,2,\ldots, s$, $\sum_{j=1}^{n} \lambda_j x_{ij} + s_i^{-} = \theta x_{ik}, i = 1,2,\ldots, m$ $\lambda_j, s_i^{-}, s_r^{+} \geq 0, \quad za \quad \forall i, j, r.$ $j = 1,2,\ldots, n$	$\max z = \sum_{r=1}^{s} u_r y_{rk}$, on conditions $\sum_{i=1}^{m} v_i x_{ik} = 1, u_r \geq 0, v_i \geq 0,$ $\sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ik} \leq 0$, j =1,2, …, n. $u_r \geq \varepsilon, v_i \geq \varepsilon > 0$
Output orientation	
Envelopment model	Multiplicative model
$\phi^{*} = \max \phi + \varepsilon\left(\sum_{r=1}^{s} s_r^{+} + \sum_{i=1}^{m} s_i^{-}\right)$. on conditions that $\sum_{j=1}^{n} \lambda_j y_{rj} - s_r^{+} = \phi y_{rk}, r = 1,2,\ldots, s$, $\sum_{j=1}^{n} \lambda_j x_{ij} + s_i^{-} = x_{ik}, i = 1,2,\ldots, m$ $\lambda_j, s_i^{-}, s_r^{+} \geq 0, \quad za \quad \forall i, j, r.$ $j = 1,2,\ldots, n$	$\min\ q = \sum_{i=1}^{m} v_i x_{iik}$, on conditions $\sum_{r=1}^{s} u_r y_{rk} = 1, u_r \geq 0, v_i \geq 0,$ $\sum_{i=1}^{m} v_i x_{ik} - \sum_{r=1}^{s} u_r y_{rj} \geq 0$, j =1,2, …, n. $u_r \geq \varepsilon, v_i \geq \varepsilon > 0$

5. IMPLEMENTATION OF DEA MODEL IN BANKS

We wil continue to describe the implementation of the DEA method in the banking sector of Serbia. In the implementation of the model we used the data on the number of employees and capital as inputs, and only the total income as the output, since the profit after tax in certain banks is negative. Due to unavailability of data only three years were observed, 2008., 2009.

and 2010. throughout the serbian banking sector. This is the author's preliminary research model (see other - [8] and [6]).

Table 3. DEA efficiency coefficients for the years 2008., 2009. and 2010.

Banks	***CRS efficiency coefficients***			***Change in efficiency***	
				Ek	***Ek***
	2008	***2009***	***2010***	***2009/2008***	***2010/2009***
Banca Intesa	**1.0000**	**1.0000**	**1.0000**	100	100
Komercijalna banka	0.7074	0.7848	0.6565	110.94	83.65
EFG Eurobank	0.7414	0.7624	0.7200	102.82	94.44
Raiffeisenbank	0.7634	0.7206	0.6791	94.39	94.24
UniCredit bank	0.7944	0.8310	0.9861	104.61	118.66
Hypo-Alpe-Adria bank	0.9485	0.7959	0.8987	83.91	112.91
AIK banka	**1.0000**	**1.0000**	**1.0000**	100.00	100.00
Societe Generale	0.8805	0.8890	0.7918	100.96	89.07
Alpha bank	0.6113	0.4466	0.5247	73.06	117.49
Vojvođanska banka	0.4880	0.3800	0.3292	77.88	86.61
Volks banka	0.7157	0.7107	0.7777	99.30	109.43
Agrobanka	0.5772	0.7121	0.8018	123.36	112.59
ProCredit bank	0.9208	0.7938	0.6995	86.20	88.12
Erste bank	0.8155	0.7660	0.6729	93.93	87.85
Piraeus bank	0.5697	0.5968	0.5963	104.76	99.92
NLB banka	0.9332	0.9358	0.7270	100.28	77.69
Credit Agricole bank	0.6257	0.5973	0.5064	95.47	84.79
OTP banka	0.5154	0.4757	0.4463	92.28	93.83
RB Vojvodine	0.7946	0.5863	0.6983	73.79	119.10
Univerzal banka	**1.0000**	**1.0000**	0.9240	100.00	92.40
Poštanska štedionica	**1.0000**	**1.0000**	0.6513	100.00	65.13
PB Beograd	0.7423	**1.0000**	**1.0000**	134.71	**100.00**
KBC banka	0.3988	0.3796	0.3610	95.18	95.12
Čačanska banka	0.8268	0.7603	0.6901	91.95	90.77
Marfin bank	0.5560	0.4045	0.4277	72.76	105.72
Findomestic bank	0.7225	0.7854	0.6857	108.70	87.31
Srpska banka	0.4849	0.4138	0.5018	85.34	121.28
Credy banka	0.8715	**1.0000**	0.3455	114.74	34.55
JUBMES banka	0.4321	0.3996	0.4333	92.49	108.42
Jugobanka Jugbanka	0.0817	0.0802	0.1212	98.14	151.12
Opportunity banka	0.6285	0.6997	0.4949	111.33	70.74
Dunav banka	0.3529	0.3312	0.1169	93.86	35.30
Bank of Moscow Belgrade	0.1133	0.3034	0.3745	267.88	123.43

The overall efficiency of banks was calculated using the *Excel Solver* with the condition that the output, i.e., the overall income, be larger for the given inputs that are minimized. The results are shown on Table 3.

The efficiency coefficients indicate a relative ranking of the bank in a group of banks in accordance with an efficiency bottomline of the banking sector for each year. During the years under study the efficiency of certain banks changed. Only two banks (Banca Intesa and AIK bank) were 100% efficient over all the three observed years, whereas the Universal banka and Poštanska štedionica were efficient only in 2008 and 2009. In 2010, the Universal banka recorded a 92.40% efficiency and Poštanska štedionica plummetted to 65.13%.

If $E_k > 1$, it means a relative positive change in efficiency, while $E_k < 1$ means that efficiency is reduced. For $E_k = 1$, it means that DMUs retained the same relative level.

The table above shows that efficiency varied from bank to bank, year after year. In case of some banks it rose, in others it fell. For example, the Credy banka had a 100% efficiency in 2009, to fall to only 34.25% efficiency in 2010.

It is interesting to analyse two banks (Banca Intesa and AIK banka) that, according to the DEA method reported a 100% efficiency over all the three observed years. Banca Intesa recorded an average 9.81% increase in productivity while the AIK banka reported an average 4.04% fall year after year. The analysis of absolute data on the number of employees and the total income for these two banks revealed that the AIK bank retained an approximately same number of employees and total income, whereas Banca Intesa experienced significant changes in each of the three years, the greatest change being in the rise of the total income which is shown by the productivity index.

The minimum efficiency per banks for the years under study is:

2008	2009	2010
0.0817	0.0802	0.1169

The average efficiency of the banking sector in Serbia per these years is:

2008	2009	2010
0.6853	0.6770	0.6255

We also observed the input combination model (assets, capital, number of employees) with the output (total income and profit before tax) showing a similar bank efficiency as our presented model. Hereinafter the efficiency table for this model is presented only for the year 2010, since the efficiency trend in 2008 and 2009 is approximately equal to that shown in Table 2.

Table 4. Bank efficiency coefficients for the year 2010.

Banks	Efficiency	Banks	Efficiency	Banks	Efficiency
Banca Intesa	**1.0000**	Agrobanka	0.8736	KBC banka	0.4844
Komercijalna banka	0.7362	ProCredit bank	0.8582	Čačanska banka	0.7792
EFG Eurobank	0.7453	Erste bank	0.7398	Marfin bank	0.5332
Raiffeisenbank	0.7663	Piraeus bank	0.5775	Findomestic bank	0.7905
UniCredit bank	0.9408	NLB banka	0.7527	Srpska banka	0.7230
Hypo-Alpe-Adria bank	0.8792	Credit Agricole bank	0.6158	Credy banka	0.5569
AIK banka	**1.0000**	OTP banka	0.4955	JUBMES banka	0.8845
Societe Generale	0.7887	RB Vojvodine	0.8110	Jugobanka Jugbanka	**1.0000**
Alpha bank	0.6080	Univerzal banka	**1.0000**	Opportunity banka	0.9553
Vojvođanska banka	0.4098	Poštanska štedionica	**1.0000**	Dunav banka	**1.0000**
Volks banka	0.7426	PB Beograd	**1.0000**	Bank of Moscow, Belgrade	**1.0000**

This model also proved that the efficiency of Banca Intesa and AIK banka was 100%, while Poštanska štedionica had a 65.13% efficiency according to the model above, and now is 100% efficient (Table 4). Efficiency coefficients are slightly higher in comparison with the results presented in Table 3 above. In addition to these three banks, an 100% efficiency was recorded by the following banks: Univerzal banka, Jugobanka, Dunav banka and Bank of Moscow Belgrade. A conclusion can be drawn that even small banks can do business efficiently. If tha data on efficiency on Tables 3 and 4 for the year 2010 are compared, it is evident that this expanded input and output model gives higher efficiency coefficients, which is only logical. The DEA method allows for a higher optimization of a given sector (banking sector in this case) on the basis of the observed empirical data from the financial statements.

A further analysis of productivity and efficiency tables is left to the readers will to conduct. The comparison of these tables can result in quality conclusions, which is specific of banking analysts who are well acquainted with the business operations of banks in Serbia.

6. CONCLUDING REMARKS

The described power of the bank profitability, productivity and performance indicators increases through the comparison of one particular bank with:

- Achievements of the bank under study in a successive period;
- Achieved indicators of competitior-banks;
- Target values of indicators determined by the bank's management team when defining the strategic orientation.

The strategic decisions for the bank are made in order that the business process should be focused on goal setting. The precondition for defining target values is obtaining information, and the goal identification itself is the information processing process, that is, the information at the bank's disposal.

The bank's strategic goals are of crucial importance since they should ensure its survival on the market, and then a long-term growth and development. Closely associated are the bank's efficiency and effectiveness, as well as profitability and productivity as target functions.

The objective of this paper was to present modern scientific methods used in assessing bank efficiency. In a real environment for the implementation of the DEA method, inputs and outputs should be selected that are highly important in evaluating the efficiency level in the operations of banks. It is, however, important to stress that new scientific methods should be applied as supplement to classic analysis of financial statements using familiar efficiency indicators.

In testing varied combinations of inputs and outputs using the DEA method, e.g. if the input consists of deposits and loans, and the output consists of assets, the efficiency coefficients show the same trend as our described model. Besides, further research into the banking sector can be oriented to comparisons of efficiency of national banks vs. foreign banks, again implementing the DEA method. The model of combination of input (assets, capital, number of employees) and output (total income and profit before tax) presented only for the year 2010 proves that efficiency can be assessed on multiple inputs and outputs and that efficiency shows a highly similar trend. A detailed analysis of the banking sector in Serbia in terms of efficiency will be the topic of future research, as will be the calculation of the Malmquist productivity index over a longer period of time. The DEA method allows for the optimization of a certain sector (in this case, banking sector) on the basis of empirical data retrieved from financial statements. The optimization is not part of this paper, however, it can be presented to the interested readers.

On the other hand, information from the financial statements can be further used to obtain regression models between respective inputs and outputs. For example, a regression model was obtained during this study between the output observed and the $Yc = -548.902,12 + 0,30X_1 + 3.072,57X_2$. input. The regression model represents well the empirical data for the banking sector of Serbia. The correlation between Y and (X_1, X_2) is rather high and amounts to 0.91. The regression model can be used to assess and anticipate the behaviour of dependent variable of the output with a certain slight risk, on the basis of changes in independent input values. For example, if X_1 = 40,000,000 and X_2 = 1,500, the total income amounts to 15,923,171.13 dinars.

With a large number of computer software programmes for financial statement analysis developed today it is possible to implement a variety of scientific methods that can support the classical method of assessing bank efficiency, as well as efficiency of many other companies throughout the economic branches of a society.

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