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Evaluating Bank Efficiency in the West Balkan Countries Using Data Envelopment Analysis

Aleksandra Marcikić Horvat [1], Nada Milenković [1,*], Branislav Dudić [2,3,*], Branimir Kalaš [1], Boris Radovanov [1] and Alexandra Mittelman [2]

[1] Faculty of Economics in Subotica, University of Novi Sad, 24000 Subotica, Serbia
[2] Faculty of Management, Comenius University Bratislava, 82005 Bratislava, Slovakia
[3] Faculty of Economics and Engineering Management, University Business Academy, 21000 Novi Sad, Serbia
* Correspondence: nada.milenkovic@ef.uns.ac.rs (N.M.); branislav.dudic@fm.uniba.sk (B.D.)

Abstract: The financial systems of the West Balkan countries are mainly based on banks. For an efficient financial system, it is of immense importance that the banks operating in it do so with high levels of efficiency. Furthermore, efficiency is needed when it comes to involving banking institutions in the financial flows in order to maintain sustainability of the financial construction. The aim of this paper is to determine whether there is a difference in efficiency between the considered countries and thus to show which changes the decisionmakers have to make in order to improve the efficiency of their banking systems. We analyze data from the revised financial statements of all banks operating in Albania, Bosnia and Herzegovina, Montenegro, North Macedonia and Serbia for the period from 2015 to 2019, using loans and investment as input variables and interest income, non-interest income and net income as output variables. The results obtained from the output-oriented DEA model with a variable return to scale have shown higher efficiency levels in North Macedonia, Bosnia and Herzegovina and Montenegro, while Serbia and Albania show lower efficiency. The individual analyses have shown that in order to improve efficiency levels, improvement is needed more in the correction of the investment amounts then in loan placements.

Keywords: bank efficiency; finance sustainability; data envelopment analysis; profit approach; West Balkan countries

MSC: 90C08

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1. Introduction

The main gain of banking institutions, as profit institutions, is to generate high net incomes using the available assets. Banks also perform a responsible function as intermediaries, which should be taken into account when analyzing the overall operations of banks. Banking institutions have a crucial role in ensuring the sustainability of companies; therefore, they play an important role both for the companies and for the sustainability of the financial markets, especially when the market is bank-oriented. To ensure the long-term relationships between companies and banks, it is important to make the partnership more efficient in order to save time and costs [1]. Since banks are involved in financial flows, they are under the strict scrutiny of regulatory authorities. After the Global Financial Crisis, the Basel Committee strengthened the capital requirements of banks [2]; on that basis, banks can be considered efficient in terms of business security and solvency. Furthermore, a revised Basel III standard of exposure to banks' credit risk-weighted assets is to be applied in 2023 [3]. To be sure, that the banks' levels of efficiency are also influenced by macroeconomic factors such as market structure, legal regulations, GDP per capita, etc. [4]. Furthermore, financially stable and larger banks are ready to enter into more risky and long-term financial constructions. This is important for the sustainable operation of the banks in the financial

markets. Measuring and monitoring profit efficiency can improve the profit margin in order to improve the position of banks in relation to competitors.

Efficiency in the bank industry draws attention both from the academic community and from policymakers. Data envelopment analysis (DEA) is applicable in the banking industry and is widely used to measure efficiency in order to provide a reliable basis for decisionmaking. Unfortunately, there is a lack of academic literature focusing on the usage of DEA in the banking industry, especially the profitability approach. The banks' profitability in the academic literature is mainly considered in terms of the determinants affecting it, but there is not enough literature considering the improvement of profits by using the DEA profitability approach.

Charnes, Cooper and Rhodes [5] used data envelopment analysis for the first time in their research paper, after which researchers began applying DEA to problems in all fields of economics. The first focus of DEA applications was for managers' purposes, i.e., for decisionmaking processes about the units in their organizations; since then, DEA has continued to focus on improving the performance of the decisionmaking unit (DMU). DEA primarily measures technical efficiency by focusing on levels of input relative to levels of output; this is different to the concept of economic efficiency, which would include prices in the analysis. There are three basic DEA models used by researchers: radial-, additive- and slack-based measurement models. Recently, DEA models have frequently been used for measuring the efficiency of microfinancial institutions [6–12]. In addition, depending on the banking function for which the efficiency is being measured, there are also the operating, intermediary and profitability approaches.

The aim of this paper is to analyze the efficiency of the banking institutions operating in West Balkan countries in the period from 2015 to 2019. For this purpose, we are using the profitability approach of the DEA model. In doing so, our intention is to contribute to the shrinking of the existing gap in the academic literature.

The paper is divided into six sections, as follows. After the Introduction, a literature review of DEA applications in the banking industry is performed in order to position our research within a wide range of models and applications of DEA. In the Methodology and Data section, the sample and methodology of the DEA application are explained. In the next section, the results of our research are explained and discussed. In the last section, Concluding Remarks, we draw some final conclusions and give recommendations for further research.

2. Literature Review

In the literature, there are three commonly applied DEA approaches. First, the service-oriented approach, which is mainly used in the analysis of branch efficiency [13]. Second, the intermediation approach is used in relation to the banks using deposits to generate loans. Finally, there is the revenue- or profit-oriented approach. These approaches do not conflict; indeed, they are complementary in providing information on bank efficiency in three important bank functions. The first approach is branch-oriented; the second and third approaches are used to measure between banks and make cross-country comparisons of banks [11]. There are a few studies comparing bank efficiency levels by using analysis made with all approaches [14–16]. Moreover, some hybrid models have been developed which combine the operational and intermediary approaches [17].

Besides these three approaches, the two-stage DEA network model is commonly used by researchers. In such cases, the DMUs can have two-stage structures. The first stage uses inputs to generate outputs which become the inputs for the second stage [7]. Two-stage DEA network models can combine cost efficiency and productive efficiency [18]. In this model, branch efficiency is measured in the first stage, where the number of branches and number of employees are set as input variables, and administrative and personnel expenses are generated as output variables. In the second stage, where bank productivity is measured, equity and permanent assets are generated as outputs.

Liu et al. [19], as well as Seiford & Zhu [20] and Lu & Lo [10], are evaluating the efficiency of commercial banks using two-stage DEA, in which the first stage measures the profitability performance of the banks and the second stage measures the market performance. Besides the two-stage DEA efficiency measurement, Liu et al. [19] and many other researchers [21,22] are trying to resolve the appearance of undesirable variables.

Wang et al. [23] utilize the network DEA approach to disaggregate, evaluate and test the efficiencies of 16 major Chinese commercial banks using two-stage DEA models. In this research, two cases are considered: firstly, the deposit-producing process, and secondly, the profit-earning process. The first sub-process is the intermediate measure, where the input variables are fixed assets and the number of employees. The output is one variable—bank deposits. This output is referred to as intermediate input/output because it is the output of the first-stage analysis but also the input of the second-stage analysis. The second-stage analysis is profit-oriented, and the outputs of this second stage are mainly profitability measures in all their manifestations (non-interest incomes, interest incomes and one undesirable output—non-performing loans).

Two-stage DEA network models use different inputs and outputs according to the type of efficiency which they are measuring. Two-stage analysis in the literature also includes efficiency analyses with a regression model [24–31].

Regardless of the approach used, DEA technical efficiency models can be input- or output-oriented, depending on the desirable decisionmaking demand. According to this, it can measure the ability to obtain the maximum output without modifying the inputs, and it can also measure the achievement of the given output levels by minimizing the input variables. In the literature which considers bank efficiency, it is assumed that the bank chooses a business model that minimizes costs given its output mix and input prices or that it maximizes profits given the prices of its inputs and outputs [32].

Besides the issue of which DEA model to use, there is a further issue: which inputs and outputs to use according to the desired efficiency analysis. There are a variety of DEA models used in the banking industry depending on the approach used in the research. These varieties entail a wide range of inputs and outputs used in previous research.

There is no consensus in the literature regarding the input and output variables' measuring costs or profit efficiency in banks. It is important to note that deposits are considered as both input and output variables depending on the considered approach and that there is disagreement regarding the role of deposits in the bank production process [33].

Since we use the profitability approach, we are using loans and investment as input variables. As output variables, we are using net interest income, net non-interest income and net income.

In West Balkan countries, loans and investment are the most common placements of the banking institutions, and these input variables generate the incomes in banks. Here, we do not perform a detailed analysis of the efficiency of managing a particular cost category; instead, we are focusing on the efficiency of generating profit based on available placements. Since loans and investment are the output variables in the intermediary approach [29,34,35], we use them as input variables in our profit-oriented model.

The output variables are the categories of the incomes which are generated from the input variables. We use the output variables used by Wang et al. [23] in the profit-earning sub-process, with a slight modification: we use net income instead of non-performing loans, which is an undesirable variable.

Since the aim of the research was to determine the efficiency of generating net incomes, the profitability approach was used for that purpose. The profitability approach has a variety of perspectives in the literature regarding the input and output variables. The use of the specific input and output variables depends mostly on the demand of the DMU. Our model is based on the modification of the two-stage network DEA used by Wang et al. [23]. Figure 1 shows the construction of our model.

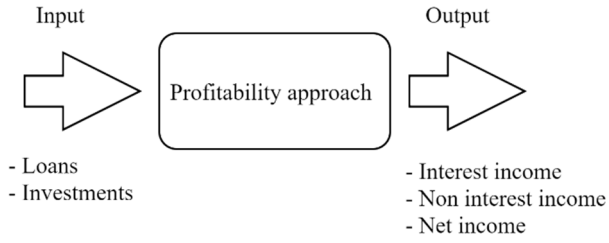

Figure 1. Model construction.

3. Methodology and Data

Data envelopment analysis (DEA) is a well-known nonparametric approach for efficiency analysis of selected decisionmaking units (DMUs), which can be successfully applied in various areas, both on micro- and macro-economic levels. Unlike the parametric statistical approaches, this method compares the efficiency of each DMU with the highest efficiency score in the sample, rather than the mean value. DEA is based on linear programming models and efficiency is observed as relation between selected output and input variables. The results of the DEA model are relative efficiency measures because they highly depend on the selected sample and variables. Results of the DEA method show how many DMUs are ineffective compared to the effective ones. It is also possible to suggest the desired changes of input and output variables in order to improve the efficiency score of inefficient units.

Recently, numerous variants of the DEA model have been developed. In this section, the output-oriented DEA model with a variable return to scale has been used to examine the efficiency of banks operating in the Western Balkan countries. The choice of DEA model orientation depends on whether decisionmakers have more interest in improving input or output levels. The output-oriented model tries to determine the maximum possible proportional increase of outputs while keeping the levels of used inputs constant. The analysis is performed by solving the following model (developed by Banker, Charnes and Cooper in 1984 [36]) of linear programming for each DMU and each period of time:

$$\begin{aligned} \max & \phi \\ & s.t. \sum_{j=1}^{n} x_{ij}\lambda_j \le x_{io} \quad i = 1, 2, \ldots, m; \\ & \sum_{j=1}^{n} y_{rj}\lambda_j \ge \phi y_{ro} \quad r = 1, 2, \ldots, s; \\ & \sum_{j=1}^{n} \lambda_j = 1 \\ & \lambda_j \ge 0 \end{aligned} \tag{1}$$

where n is the number of DMUs (decisionmaking units—countries in our case) and DMU_o represents the country under evaluation. Assuming that we have s output variables and m input variables, observed output and input values are y_r and x_i, respectively, thus y_{ro} is the amount of output r used by DMU_o, while x_{io} is the amount of input i used by DMU_o. λ is the DMU's weight, and the efficiency score is ϕ.

Our research assessed the change in technical efficiency of banks in Albania, Bosnia and Herzegovina, North Macedonia, Montenegro and Serbia over the period of five years, from 2015 to 2019. The data were retrieved from the Revised Financial Statements published on the websites of the analyzed commercial banks and from the National Bank of Serbia for the aforementioned time period. Our sample includes 79 banking institutions. Based on the comprehensive analysis of previous research and the main objective of this study, three output and two input variables were selected for the DEA model. Interest income, non-interest income and net incomes were used as output variables, while loans and investments were used as input variables. All variables are presented in national currencies. Descriptive statistics for selected inputs and outputs are presented in Table 1, for the first

and the last year in the sample. From the data presented in the following table, it can be concluded that all observed variables have an increasing trend.

Table 1. Descriptive statistics of input and output variables.

Country	Year		Net Income	Interest Income	Non-Interest Income	Loans	Investment
Albania	2019	Average	2,182,009.00	3,964,383.58	1,929,458.50	69,770,630.75	27,533,639.92
		Standard deviation	4,918,637.24	3,787,890.24	3,899,569.16	68,412,563.79	24,782,724.68
	2015	Average	2,430,787.00	4,507,287.00	645,042.25	54,687,810.92	20,539,133.17
		Standard deviation	5,928,260.00	4,516,227.76	776,113.25	60,200,729.41	19,404,261.34
Bosnia and Herzegovina	2019	Average	17,287.56	46,776.06	22,055.19	931,199.06	82,138.75
		Standard deviation	27,159.22	52,940.92	26,740.54	991,735.62	138,146.81
	2015	Average	16,624.06	46,637.19	16,486.88	670,763.75	43,664.31
		Standard deviation	24,452.08	54,731.49	21,256.36	757,178.96	104,952.98
North Macedonia	2019	Average	633,758.00	1,078,852.75	320,720.92	24,664,780.33	4,724,654.08
		Standard deviation	885,471.06	1,218,672.80	369,819.22	24,311,118.89	6,290,252.62
	2015	Average	340,783.00	926,206.38	297,410.15	19,155,675.15	3,125,366.77
		Standard deviation	613,914.54	1,081,907.55	358,231.48	20,811,575.50	4,252,714.64
Montenegro	2019	Average	3418.75	14,965.92	7191.17	264,095.50	43,547.08
		Standard deviation	3593.61	10,820.85	5961.69	219,775.40	44,111.54
	2015	Average	1671.55	14,800.36	5928.45	207,445.73	22,525.91
		Standard deviation	2201.60	11,055.29	4821.35	162,602.50	27,174.42
Serbia	2019	Average	2,506,483.19	4,953,285.12	1,618,609.12	100,017,838.62	103,426,368.69
		Standard deviation	3,560,179.81	5,180,549.50	1,915,084.06	103,560,174.11	110,337,709.55
	2015	Average	1,286,608.04	4,685,108.92	1,279,458.72	46,058,770.68	22,386,434.12
		Standard deviation	2,248,471.17	5,216,916.88	1,510,680.05	57,787,376.98	33,011,839.53

Source: Authors' calculations.

4. Results and Discussion

The results obtained from the output-oriented DEA model with a variable return to scale are shown in Figure 2 and Appendix A. Linear programming model (1) is solved for all banks that operate on the national market, separately, for every year and every country. Achieved average efficiency scores are presented in Figure 2. The results of efficiency scores lie between 0 and 1, i.e., between 0% and 100%. From the presented results it can be concluded that banks in the Western Balkan countries operate at enviable levels of efficiency since the average score is above 65% in the observed time period. North Macedonia, Bosnia and Herzegovina and Montenegro achieved extremely high efficiency levels (above 90%) during the whole time period. Albania has a decreasing trend in the average efficiency score, while Serbia has the lowest average efficiency in the first three years.

All banks that have efficiency score less than 100% may improve achieved efficiency by increasing the level of selected outputs with the constant input level, since the performed DEA model was output-oriented. Therefore, apart from the information on efficiency score, DEA also provides useful information for decisionmakers on possible methods of efficiency improvement for banks. This information is presented in Appendices B and C. These tables include results of the applied DEA model (1) for the last year in the dataset (2019). Proportionate movements of input and output variables are presented in Appendix B together with slack movements. Since the selected DEA model is output-oriented, proportionate movements of output variables show necessary increase of the output levels in order to achieve the highest efficiency score. Usually, besides the aforementioned proportionate movements, it is necessary to take into account the values of slack variables. Coelli et al. [37] stated that it is important to report both the scores of technical efficiency and any non-zero

input and output slacks to provide an accurate indication of technical efficiency of a unit in a DEA analysis. So, it is particularly important to interpret and present slack values together with the efficiency values. Indeed, slacks are only the leftover portions of inefficiencies after proportional reductions in inputs or outputs.

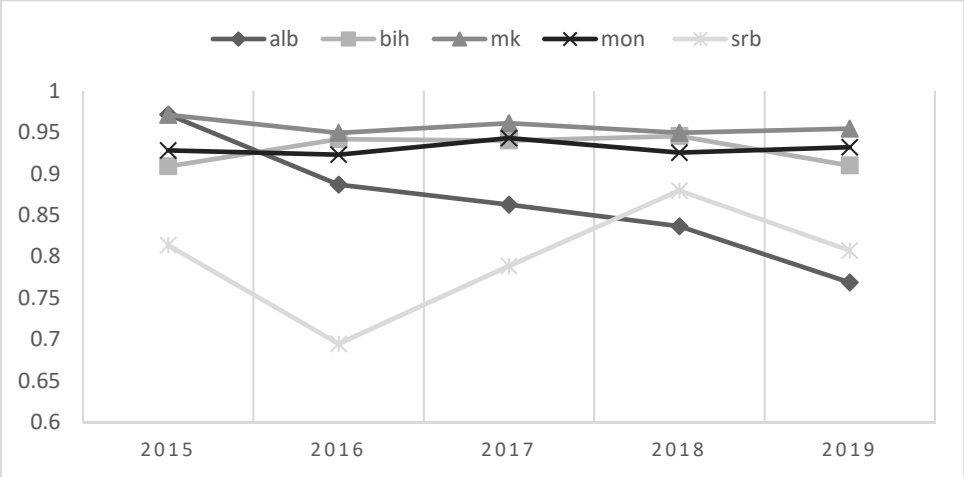

Figure 2. Average Efficiency Score per year, per country. Source: Authors' calculations.

Therefore, for example, if we want to make a suggestion to bank Albania1 to improve its efficiency, we should take into account both proportionate movements, i.e., increase in output variables (net income for 202,613.14 ALL, interest income for 3,481,878.39 ALL and non-interest income for 718,482.59 ALL), as well as slack movements, i.e., reduction in investments for 10,319,445.95 ALL, together with further slack increase of net income for 847,510.25 ALL. This way, we generate the projected input and output variable values needed to achieve the maximal level of efficiency for every country. Those projections are presented in Appendix C. Generally, banks in Western Balkan countries that did not achieve maximal relative efficiency should aim to increase net income, interest income and non-interest income; this is achievable by reducing investments. Moreover, banks as organizations should collaborate in order to reach the appropriate level of efficiency [38].

5. Concluding Remarks

Our research focuses on determining the level of efficiency of banks in the banking systems of West Balkan countries without going into the reasons of their efficiency or inefficiency. The markets with more efficient banking institutions are stable and can ensure more sources for companies and various projects for enhancing their sustainability. From the results of the DEA analysis, it can be concluded that the Republic of North Macedonia, Montenegro and Bosnia and Herzegovina have shown elevated levels of efficiency. In contrast, Serbia and Albania are struggling with efficiency levels, although Serbia had a high efficiency jump from 2016 to 2018. The levels of efficiency for each bank in the considered sample for the period from 2005 to 2019 are given in Appendix A.

The contribution of this analysis is shown in Appendix B, where the concrete efficiency improvement measures are shown. Appendix B shows the necessary slack corrections in the inputs in order to achieve higher output efficiencies (slack and proportionate). Loan placements should be cut down only in three banks in Albania. In contrast, investments should be corrected by reducing them in seven banks in Albania and seven banks in Bosnia and Herzegovina. Six banks in Serbia should reduce the placement of their investments, along with one bank in Montenegro. By reducing the input variables (mainly investment), these banks should achieve higher levels of all output variables.

Appendix C shows the projections of the input and output variables after accepting and applying the suggested variable changes.

Further research should focus on the reasons for the inefficiency of the banks in some banking systems in West Balkan countries. The West Balkan countries differ in their types and sizes of banks. In retrieving the data for the purpose of this research, we noticed that the banks operating in West Balkan countries are mainly commercial banks focusing on loan placements. In light of this, the logical suggestion would be larger corrections in investments. Another determining factor influencing efficiency levels is the recent merger and acquisition activity in West Balkan countries. Larger banks that were taken over in the past by other banks should show higher levels of efficiency compared to smaller banks, which are often takeover targets and have potential for efficiency improvements. Further, the impact of macroeconomic determinants on bank efficiency should be measured.

The limitation of our model is that it analyzes efficiency but not the determinants that influence the efficiency scores, which could also be a recommendation for further research.

From the point of view of the investors or decisionmaking units, the results of this research are valuable because of the sustainability of financing larger projects. More efficient banks can be singled out and involved in the financial flows so that they would not be endangered. In each analyzed country, the most efficient banks can be distinguished and involved in a saver financial construction. For the bank managers of each bank in each country, the findings of our study are valuable in the short, middle and long term. This because on the basis of the information in the Appendices A–C they can take concrete action in cutting down or increasing loan placements or investments in order to increase the income categories and raise the profitability levels of banks.

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Appendix A

Table A1. Results of DEA model—Efficiency Scores.

2015		2016		2017		2018		2019	
DMU	**Score**	**DMU**	**Score**	**DMU**	**Score**	**DMU**	**Score**	**DMU**	**Score**
Albania1	1.00	Albania1	0.80	Albania1	0.69	Albania1	0.41	Albania1	0.41
Albania2	1.00	Albania2	1.00	Albania2	1.00	Albania2	0.85	Albania2	0.91
Albania3	1.00	Albania3	1.00	Albania3	1.00	Albania3	0.78	Albania3	0.69
Albania4	1.00	Albania4	1.00	Albania4	1.00	Albania4	1.00	Albania4	1.00
Albania5	1.00	Albania5	0.80	Albania5	0.75	Albania5	0.64	Albania5	0.63
Albania6	1.00	Albania6	1.00	Albania6	1.00	Albania6	1.00	Albania6	1.00
Albania7	0.91	Albania7	0.88	Albania7	0.81	Albania7	0.55	Albania7	0.63
Albania8	1.00	Albania8	1.00	Albania8	1.00	Albania8	1.00	Albania8	0.59
Albania9	1.00	Albania9	1.00	Albania9	1.00	Albania9	1.00	Albania9	0.74
Albania10	0.75	Albania10	0.56	Albania10	0.53	Albania10	0.81	Albania10	0.64
Albania11	1.00	Albania11	0.60	Albania11	0.58	Albania11	1.00	Albania11	1.00
Albania12	1.00	Albania12	1.00	Albania12	1.00	Albania12	1.00	Albania12	1.00
Average	0.97		0.89		0.86		0.84		0.77
Bosnia & Herzegovina1	1.00	Bosnia & Herzegovina1	1.00	Bosnia & Herzegovina1	0.94	Bosnia & Herzegovina1	0.97	Bosnia & Herzegovina1	0.97
Bosnia & Herzegovina2	0.92	Bosnia & Herzegovina2	0.74	Bosnia & Herzegovina2	0.89	Bosnia & Herzegovina2	0.89	Bosnia & Herzegovina2	0.86

Table A1. *Cont.*

2015		2016		2017		2018		2019	
DMU	**Score**	**DMU**	**Score**	**DMU**	**Score**	**DMU**	**Score**	**DMU**	**Score**
Bosnia & Herzegovina3	1.00	Bosnia & Herzegovina3	1.00	Bosnia & Herzegovina3	1.00	Bosnia & Herzegovina3	0.84	Bosnia & Herzegovina3	1.00
Bosnia & Herzegovina4	0.93	Bosnia & Herzegovina4	0.92	Bosnia & Herzegovina4	0.94	Bosnia & Herzegovina4	1.00	Bosnia & Herzegovina4	1.00
Bosnia & Herzegovina5	1.00	Bosnia & Herzegovina5	1.00	Bosnia & Herzegovina5	1.00	Bosnia & Herzegovina5	1.00	Bosnia & Herzegovina5	1.00
Bosnia & Herzegovina6	0.87	Bosnia & Herzegovina6	0.96	Bosnia & Herzegovina6	0.99	Bosnia & Herzegovina6	0.90	Bosnia & Herzegovina6	0.96
Bosnia & Herzegovina7	1.00	Bosnia & Herzegovina7	1.00	Bosnia & Herzegovina7	0.86	Bosnia & Herzegovina7	1.00	Bosnia & Herzegovina7	0.83
Bosnia & Herzegovina8	1.00	Bosnia & Herzegovina8	1.00	Bosnia & Herzegovina8	1.00	Bosnia & Herzegovina8	1.00	Bosnia & Herzegovina8	0.89
Bosnia & Herzegovina9	1.00	Bosnia & Herzegovina9	1.00	Bosnia & Herzegovina9	1.00	Bosnia & Herzegovina9	1.00	Bosnia & Herzegovina9	1.00
Bosnia & Herzegovina10	0.61	Bosnia & Herzegovina10	0.78	Bosnia & Herzegovina10	0.67	Bosnia & Herzegovina10	0.77	Bosnia & Herzegovina10	0.61
Bosnia & Herzegovina11	1.00	Bosnia & Herzegovina11	1.00	Bosnia & Herzegovina11	1.00	Bosnia & Herzegovina11	1.00	Bosnia & Herzegovina11	1.00
Bosnia & Herzegovina12	0.89	Bosnia & Herzegovina12	0.95	Bosnia & Herzegovina12	0.97	Bosnia & Herzegovina12	0.96	Bosnia & Herzegovina12	0.92
Bosnia & Herzegovina13	1.00	Bosnia & Herzegovina13	1.00	Bosnia & Herzegovina13	1.00	Bosnia & Herzegovina13	1.00	Bosnia & Herzegovina13	1.00
Bosnia & Herzegovina14	0.86	Bosnia & Herzegovina14	1.00	Bosnia & Herzegovina14	0.90	Bosnia & Herzegovina14	0.85	Bosnia & Herzegovina14	0.69
Bosnia & Herzegovina15	0.80	Bosnia & Herzegovina15	0.93	Bosnia & Herzegovina15	1.00	Bosnia & Herzegovina15	1.00	Bosnia & Herzegovina15	1.00
Bosnia & Herzegovina16	0.66	Bosnia & Herzegovina16	0.80	Bosnia & Herzegovina16	0.88	Bosnia & Herzegovina16	0.94	Bosnia & Herzegovina16	0.83
Average	0.91		0.94		0.94		0.95		0.91
North Macedonia1	1.00	North Macedonia1	0.95	North Macedonia1	1.00	North Macedonia1	1.00	North Macedonia1	1.00
North Macedonia2	0.90	North Macedonia2	0.92	North Macedonia2	0.83	North Macedonia2	0.80	North Macedonia2	0.83
North Macedonia3	0.97	North Macedonia3	0.88	North Macedonia3	0.87	North Macedonia3	0.76	North Macedonia3	0.82
North Macedonia4	1.00	North Macedonia4	1.00	North Macedonia4	1.00	North Macedonia4	1.00	North Macedonia4	1.00
North Macedonia5	1.00	North Macedonia5	1.00	North Macedonia5	1.00	North Macedonia5	1.00	North Macedonia5	1.00
North Macedonia6	1.00	North Macedonia6	0.68	North Macedonia6	1.00	North Macedonia6	1.00	North Macedonia6	1.00
North Macedonia7	1.00	North Macedonia7	1.00	North Macedonia7	1.00	North Macedonia7	1.00	North Macedonia7	1.00
North Macedonia8	1.00	North Macedonia8	1.00	North Macedonia8	1.00	North Macedonia8	1.00	North Macedonia8	1.00
North Macedonia9	1.00	North Macedonia9	1.00	North Macedonia9	0.79	North Macedonia9	0.78	North Macedonia9	0.81
North Macedonia10	0.76	North Macedonia10	0.91	North Macedonia10	1.00	North Macedonia10	1.00	North Macedonia10	1.00
North Macedonia11	1.00	North Macedonia11	1.00	North Macedonia11	1.00	North Macedonia11	1.00	North Macedonia11	1.00
North Macedonia12	1.00	North Macedonia12	1.00	North Macedonia12	1.00	North Macedonia12	1.00	North Macedonia13	1.00
North Macedonia13	1.00	North Macedonia13	1.00	North Macedonia13	1.00	North Macedonia13	1.00		
Average	0.97		0.95		0.96		0.95		0.95
Montenegro1	1.00	Montenegro1	1.00	Montenegro1	1.00	Montenegro1	1.00	Montenegro1	1.00
Montenegro2	0.98	Montenegro2	1.00	Montenegro2	1.00	Montenegro2	1.00	Montenegro2	1.00
Montenegro3	0.77	Montenegro3	1.00	Montenegro3	0.91	Montenegro3	1.00	Montenegro3	0.82
Montenegro4	1.00	Montenegro4	1.00	Montenegro4	1.00	Montenegro4	1.00	Montenegro4	1.00

Table A1. *Cont.*

2015		2016		2017		2018		2019	
DMU	**Score**	**DMU**	**Score**	**DMU**	**Score**	**DMU**	**Score**	**DMU**	**Score**
Montenegro5	0.91	Montenegro5	0.91	Montenegro5	1.00	Montenegro5	1.00	Montenegro5	0.97
Montenegro6	0.88	Montenegro6	0.84	Montenegro6	0.86	Montenegro6	0.61	Montenegro6	0.72
Montenegro7	1.00	Montenegro7	0.91	Montenegro7	1.00	Montenegro7	1.00	Montenegro7	1.00
Montenegro8	1.00	Montenegro8	0.42	Montenegro8	0.58	Montenegro8	0.57	Montenegro8	1.00
Montenegro9	0.67	Montenegro9	1.00	Montenegro9	0.96	Montenegro9	0.92	Montenegro9	0.94
Montenegro10	1.00	Montenegro10	1.00	Montenegro10	1.00	Montenegro10	1.00	Montenegro10	0.74
Montenegro11	1.00	Montenegro11	1.00	Montenegro11	1.00	Montenegro11	1.00	Montenegro11	1.00
		Montenegro12	1.00	Montenegro12	1.00	Montenegro12	1.00	Montenegro12	1.00
Average	0.93		0.92		0.94		0.93		0.93
Serbia1	0.42	Serbia1	0.46	Serbia1	0.26	Serbia1	0.57	Serbia1	1.00
Serbia2	0.51	Serbia2	0.41	Serbia2	0.72	Serbia2	0.79	Serbia2	1.00
Serbia3	0.68	Serbia3	0.98	Serbia3	1.00	Serbia3	0.98	Serbia3	1.00
Serbia4	1.00	Serbia4	1.00	Serbia4	1.00	Serbia4	1.00	Serbia4	1.00
Serbia6	1.00	Serbia5	0.00	Serbia5	1.00	Serbia5	1.00	Serbia5	1.00
Serbia7	1.00	Serbia6	1.00	Serbia6	1.00	Serbia6	1.00	Serbia6	1.00
Serbia8	1.00	Serbia7	0.89	Serbia7	1.00	Serbia7	1.00	Serbia7	0.67
Serbia9	1.00	Serbia8	0.46	Serbia8	0.89	Serbia8	1.00	Serbia8	0.77
Serbia10	0.92	Serbia9	1.00	Serbia9	0.87	Serbia9	0.78	Serbia9	0.68
Serbia11	1.00	Serbia10	0.70	Serbia10	1.00	Serbia10	1.00	Serbia10	0.73
Serbia12	0.70	Serbia11	0.47	Serbia11	1.00	Serbia11	0.66	Serbia11	0.59
Serbia13	0.32	Serbia12	0.67	Serbia12	0.77	Serbia12	0.81	Serbia12	0.71
Serbia14	1.00	Serbia13	0.30	Serbia13	0.39	Serbia13	1.00	Serbia13	0.53
Serbia15	1.00	Serbia14	1.00	Serbia14	1.00	Serbia14	1.00	Serbia14	1.00
Serbia16	0.48	Serbia15	0.35	Serbia15	0.26	Serbia15	1.00	Serbia15	1.00
Serbia17	0.73	Serbia16	0.40	Serbia16	0.62	Serbia16	0.72	Serbia16	0.69
Serbia18	1.00	Serbia17	0.67	Serbia17	0.82	Serbia17	0.78	Serbia17	0.64
Serbia19	1.00	Serbia18	1.00	Serbia18	1.00	Serbia18	1.00	Serbia18	0.83
Serbia20	1.00	Serbia19	1.00	Serbia19	1.00	Serbia19	1.00	Serbia19	1.00
Serbia21	1.00	Serbia20	1.00	Serbia20	0.92	Serbia20	0.69	Serbia20	0.42
Serbia22	0.75	Serbia21	1.00	Serbia21	1.00	Serbia21	1.00	Serbia21	0.98
Serbia23	1.00	Serbia22	0.59	Serbia22	0.84	Serbia22	0.79	Serbia22	0.60
Serbia24	0.20	Serbia23	1.00	Serbia23	0.29	Serbia23	0.76	Serbia23	0.58
Serbia25	1.00	Serbia24	0.30	Serbia24	0.36	Serbia24	1.00	Serbia24	0.85
Serbia26	0.63	Serbia25	1.00	Serbia25	0.85	Serbia25	0.90	Serbia25	0.93
		Serbia26	0.41	Serbia26	0.64	Serbia26	0.65	Serbia26	0.79
Average	0.81		0.69		0.79		0.88		0.81

Appendix B

Table A2. Results of DEA model—Proportionate and Slack Movements.

DMU	Slack Movement (Loans)	Slack Movement (Investment)	Proportionate Movement (Net Income)	Slack Movement (Net Income)	Proportionate Movement (Interest Income)	Slack Movement (Interest Income)	Proportionate Movement (Noninterest Income)	Slack Movement (Noninterest Income)
Albania1	0.00	−10,319,445.95	202,613.14	847,510.25	3,481,878.39	0.00	718,482.59	0.00
Albania2	0.00	−27,899,515.18	76,750.49	0.00	292,524.53	0.00	29,939.40	464,962.48
Albania3	−11,111,297.70	−51,942,814.93	577,021.78	307,502.22	3,692,202.13	0.00	676,773.77	0.00
Albania4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Albania5	0.00	−57,494,552.35	1,024,688.22	0.00	2,595,880.93	0.00	511,601.93	1,076,794.51
Albania6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Albania7	0.00	−15,110,197.52	549,840.32	0.00	2,234,970.67	0.00	392,761.91	356,585.44
Albania8	−6,145,130.24	0.00	0.00	456,073.52	758,397.49	0.00	184,096.65	0.00
Albania9	−4,134,606.26	−47,690,708.77	1,070,162.48	1,187,914.10	2,524,782.20	0.00	1,188,102.91	0.00
Albania10	0.00	−23,745,094.65	0.00	694,461.18	1,296,737.66	0.00	269,989.03	0.00
Albania11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Albania12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bosnia& Herzegovina1	0.00	−169,260.74	216.84	0.00	888.71	0.00	499.56	192.11
Bosnia&Herzegovina2	0.00	−422.38	937.31	0.00	2639.96	0.00	1247.68	260.28
Bosnia& Herzegovina3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bosnia& Herzegovina4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bosnia&Herzegovina5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bosnia& Herzegovina6	0.00	−59,089.27	831.75	0.00	1920.37	1946.13	1173.16	0.00
Bosnia&Herzegovina7	0.00	0.00	704.68	1173.73	2416.64	0.00	1444.03	0.00
Bosnia& Herzegovina8	0.00	0.00	94.30	4852.05	1809.09	0.00	719.09	908.30
Bosnia& Herzegovina9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bosnia&Herzegovina10	0.00	0.00	232.13	2683.05	4402.01	0.00	1124.43	3416.21
Bosnia& Herzegovina11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bosnia&Herzegovina12	0.00	−40,542.07	2129.53	0.00	5046.25	0.00	2382.05	1034.28
Bosnia& Herzegovina13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bosnia& Herzegovina14	0.00	−170,988.28	105.69	953.88	4864.25	0.00	1257.39	3549.39
Bosnia&Herzegovina15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bosnia& Herzegovina16	0.00	−3528.42	245.54	6238.91	7206.06	0.00	2058.61	5182.77

Table A2. *Cont.*

DMU	Slack Movement (Loans)	Slack Movement (Investment)	Proportionate Movement (Net Income)	Slack Movement (Net Income)	Proportionate Movement (Interest Income)	Slack Movement (Interest Income)	Proportionate Movement (Noninterest Income)	Slack Movement (Noninterest Income)
Montenegro1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Montenegro2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Montenegro3	0.00	0.00	263.97	1373.68	2513.59	0.00	1284.69	0.00
Montenegro4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Montenegro5	0.00	0.00	267.22	0.00	713.34	2187.08	379.10	0.00
Montenegro6	0.00	0.00	392.84	339.70	2142.50	0.00	779.84	961.87
Montenegro7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Montenegro8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Montenegro9	0.00	0.00	128.42	768.92	745.61	0.00	130.88	1392.09
Montenegro10	0.00	−16,814.64	86.75	660.57	1242.53	0.00	577.36	1421.85
Montenegro11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Montenegro12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
North Macedonia01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
North Macedonia02	0.00	0.00	146,061.09	430,162.49	331,972.08	0.00	68,967.74	86,935.57
North Macedonia03	0.00	0.00	59,105.55	156,525.12	146,011.86	0.00	35,403.65	12,509.40
North Macedonia04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
North Macedonia05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
North Macedonia06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
North Macedonia07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
North Macedonia08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
North Macedonia09	0.00	0.00	2343.09	161,710.78	66,340.97	0.00	17,981.85	0.00
North Macedonia10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
North Macedonia11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
North Macedonia13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Serbia1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Serbia2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Serbia3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Serbia4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Serbia5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Serbia6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table A2. *Cont.*

DMU	Slack Movement (Loans)	Slack Movement (Investment)	Proportionate Movement (Net Income)	Slack Movement (Net Income)	Proportionate Movement (Interest Income)	Slack Movement (Interest Income)	Proportionate Movement (Noninterest Income)	Slack Movement (Noninterest Income)
Serbia7	0.00	0.00	560,323.81	1,291,718.81	1,853,381.76	0.00	737,386.91	0.00
Serbia8	0.00	0.00	50,121.53	1,143,246.22	698,732.42	0.00	182,816.64	0.00
Serbia9	0.00	0.00	1,234,109.42	1,875,636.78	3,371,455.34	0.00	813,799.06	876,233.08
Serbia10	0.00	0.00	111,798.84	3,922,468.67	2,396,254.33	0.00	723,475.49	0.00
Serbia11	0.00	−1,750,533.59	0.00	191,598.26	343,859.14	0.00	88019.41	0.00
Serbia12	0.00	0.00	196,671.04	866,503.61	875,250.94	0.00	320,838.47	0.00
Serbia13	0.00	0.00	167,069.72	0.00	560,857.74	0.00	112,576.01	0.00
Serbia14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Serbia15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Serbia16	0.00	−1,499,126.32	15,235.21	104,133.04	258,680.95	0.00	6646.73	2235.07
Serbia17	0.00	0.00	268,816.84	1,050,717.76	1,349,621.18	0.00	403,279.15	0.00
Serbia18	0.00	0.00	906,321.22	3,973,124.26	2,342,622.90	0.00	698,583.66	1,482,096.34
Serbia19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Serbia20	0.00	0.00	948,596.91	1,559,275.73	3,674,282.30	0.00	1,366,286.83	0.00
Serbia21	0.00	0.00	130,012.33	849,085.29	214,911.28	424,774.38	92,386.97	0.00
Serbia22	0.00	0.00	206,714.98	3,172,506.57	2,811,632.24	0.00	1,032,623.53	0.00
Serbia23	0.00	−2,042,829.44	34,307.21	0.00	176,959.91	0.00	72,269.12	0.00
Serbia24	0.00	−5,655,027.12	0.00	160,400.98	109,457.94	0.00	33,175.83	0.00
Serbia25	0.00	−94,408,111.64	614,570.53	1,018,022.62	1,023,193.02	0.00	300,929.77	1,642,451.43
Serbia26	0.00	−11,667,424.83	1,635,536.91	0.00	1,612,317.14	576,557.60	577,392.61	0.00

Appendix C

Table A3. Results of DEA model—Projections.

DMU	Projection (Loans)	Projection (Investment)	Projection (Net Income)	Projection (Interest Income)	Projection (Noninterest Income)
Albania1	49,096,090.00	7,154,774.05	1,188,141.39	5,853,698.39	1,207,905.59
Albania2	30,533,526.00	3,925,158.82	825,290.49	3,145,487.53	786,897.87
Albania3	92,510,702.30	13,863,125.07	2,179,335.00	11,977,338.13	2,195,423.77
Albania4	5,924,760.00	797,366.00	19,144.00	273,144.00	98,344.00
Albania5	75,104,205.00	9,425,090.65	2,732,562.22	6,922,501.93	2,441,096.45
Albania6	250,782,251.00	18,271,935.00	17,523,372.00	1,752,372.00	13,957,406.00
Albania7	53,469,389.00	7,338,500.48	1,476,247.32	6,000,595.67	1,411,098.35
Albania8	19,028,341.76	2,288,243.00	456,073.52	1,830,999.49	444,464.65
Albania9	125,369,283.74	14,778,433.23	5,364,893.58	9,854,544.20	4,637,315.91
Albania10	31,179,091.00	4,530,881.35	694,461.18	3,561,298.66	741,485.03
Albania11	77,358,301.00	13,441,040.00	710,347.00	12,956,243.00	1,069,370.00
Albania12	550,0594.00	386,802.00	8778.00	321,754.00	32,785.00
Bosnia& Herzegovina1	54,2571.00	26,292.26	7506.84	30,766.71	17,486.66
Bosnia&Herzegovina2	332,833.00	49,186.62	6687.31	18,834.96	9161.96
Bosnia& Herzegovina3	890,239.00	613.00	11764.00	36,643.00	13,717.00
Bosnia& Herzegovina4	1,587,533.00	6134.00	33,923.00	78,039.00	33,208.00
Bosnia&Herzegovina5	57,713.00	4.00	1451.00	3323.00	3397.00
Bosnia& Herzegovina6	872,921.00	39,201.73	19,385.75	46,704.50	27,343.16
Bosnia&Herzegovina7	290,630.00	1184.00	5334.42	14,268.64	8526.03
Bosnia& Herzegovina8	398,254.00	279.00	5739.35	17,022.09	7674.40
Bosnia& Herzegovina9	2,889,431.00	27,913.00	56,901.00	154,930.00	96,038.00
Bosnia&Herzegovina10	204,752.00	992.00	3274.18	11,210.01	6279.64
Bosnia& Herzegovina11	973,371.00	6936.00	10,268.00	53,817.00	21,382.00
Bosnia&Herzegovina12	1,121,611.00	118,636.93	25,616.53	60,702.25	29,688.33
Bosnia& Herzegovina13	3,552,913.00	527,263.00	101,071.00	186,280.00	74,671.00
Bosnia& Herzegovina14	256,399.00	25,501.72	1293.57	15,634.25	7590.77
Bosnia&Herzegovina15	159,766.00	28,004.00	84.00	10,488.00	5732.00
Bosnia& Herzegovina16	768,248.00	12,247.58	7700.45	42,893.06	17,436.38
Montenegro1	516,982.00	80,086.00	3618.00	25,988.00	18,017.00
Montenegro2	249,776.00	134,758.00	4863.00	19,741.00	16,989.00
Montenegro3	220,571.00	32,567.00	2853.66	14,092.59	7202.69
Montenegro4	385,757.00	23,856.00	12,270.00	25,643.00	7393.00
Montenegro5	397,736.00	56,772.00	8366.22	24,520.41	11,869.10
Montenegro6	101,384.00	21,952.00	1741.54	7645.50	3744.71
Montenegro7	188,391.00	296.00	3369.00	13,954.00	3451.00
Montenegro8	103,318.00	109,703.00	3241.00	4570.00	7097.00
Montenegro9	156,919.00	6841.00	2777.34	11,660.61	3438.98
Montenegro10	61,620.00	29,063.36	991.32	4737.53	3623.21
Montenegro11	773,248.00	7855.00	1216.00	35,687.00	10,195.00
Montenegro12	13,444.00	2001.00	0.00	896.00	201.00
North Macedonia01	4,375,948.00	127,348.00	44,318.00	194,678.00	73,875.00
North Macedonia02	38,120,261.00	6,852,166.00	1,278,216.58	1,927,483.08	487,373.31
North Macedonia03	16,096,746.00	2,227,346.00	480,252.68	799,722.86	206,419.06
North Macedonia04	1,662,494.00	426,020.00	17,075.00	101,251.00	23,094.00
North Macedonia05	55,484,418.00	16,016,583.00	1,826,825.00	2,404,765.00	998,984.00
North Macedonia06	9,407,635.00	9072.00	18,367.00	84,201.00	12,104.00
North Macedonia07	59,058,925.00	16,760,848.00	2,023,627.00	3,018,006.00	921,438.00
North Macedonia08	25,119,749.00	572,070.00	255,980.00	626,869.00	175,452.00

Table A3. *Cont.*

DMU	Projection (Loans)	Projection (Investment)	Projection (Net Income)	Projection (Interest Income)	Projection (Noninterest Income)
North Macedonia09	6,782,698.00	1,026,542.00	173,891.86	344,888.97	93,482.85
North Macedonia10	6,439,728.00	729,979.00	16,968.00	291,741.00	113,072.00
North Macedonia11	68,321,584.00	10,460,058.00	2,317,114.00	3,428,823.00	825,790.00
North Macedonia13	5,107,178.00	1,487,817.00	108,369.00	268,129.00	139,365.00
Serbia1	5,077,557.00	1,880,122.00	0.00	187,809.00	73,675.00
Serbia2	70,363,878.00	14,714,723.00	1,107,695.00	3,584,298.00	1,369,682.00
Serbia3	136,672,957.00	43,478,821.00	8,230,318.00	6,564,726.00	1,349,459.00
Serbia4	425,076,129.00	114,918,075.00	12,329,459.00	20,388,188.00	7,691,852.00
Serbia5	6,516,791.00	6,533,676.00	33,660.00	145,205.00	272,338.00
Serbia6	81,056,992.00	149,179,933.00	2,652,546.00	7,518,046.00	1,520,570.00
Serbia7	97,595,144.00	97,926,467.00	2,981,056.62	5,587,818.76	2,223,170.91
Serbia8	40,104,674.00	49,168,974.00	1,363,110.75	3,065,079.42	801,948.64
Serbia9	162,436,370.00	205,073,415.00	5,789,512.19	10,692,290.34	3,457,129.14
Serbia10	136,632,247.00	145,775,943.00	4,343,117.51	9,016,029.33	2,722,113.49
Serbia11	9,903,623.00	10,882,295.41	191,598.26	843,005.14	215,788.41
Serbia12	47,257,530.00	55,874,736.00	1,536,010.65	2,979,526.94	1,092,197.47
Serbia13	13,199,440.00	13,775,653.00	352,455.72	1,183,203.74	237,494.01
Serbia14	205,586,521.00	348,155,504.00	8,955,759.00	12,605,384.00	5,328,996.00
Serbia15	3,445,960.00	5,506,762.00	0.00	142,352.00	26,559.00
Serbia16	7,234,587.00	8,665,246.68	153,420.25	836,854.95	23,737.80
Serbia17	54,132,640.00	63,236,462.00	1,805,903.60	3,791,484.18	1,132,930.15
Serbia18	247,185,738.00	289,945,144.00	9,409,621.48	14,052,040.90	5,672,496.00
Serbia19	14,781,473.00	14,956,899.00	459,031.00	2,220,294.00	18,118.00
Serbia20	106,413,055.00	106,811,468.00	3,188,857.63	6,312,000.30	2,347,125.83
Serbia21	185,135,331.00	241,835,983.00	7,092,980.62	10,745,976.66	4,436,921.97
Serbia22	113,379,767.00	133,251,057.00	3,685,376.55	6,975,797.24	2,561,989.53
Serbia23	6,755,595.00	7,355,079.56	80,886.21	417,218.91	170,389.12
Serbia24	9,164,325.00	9,753,522.88	160,400.98	721,225.94	218,597.83
Serbia25	267,409,838.00	282,459,858.36	9,906,024.15	14,797,555.02	5,994,538.20
Serbia26	147,945,642.00	150,946,713.17	7,618,406.91	808,6805.74	2,689,521.61

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