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EFFICIENCY OF SERBIAN INSURANCE COMPANIES: AN APPROACH USING DATA ENVELOPMENT ANALYSIS

SCIENTIFIC WORK

Abstract

In accordance with the current situation on the insurance market and predictions for the future, the management of insurance companies must develop and implement sustainable business strategies that correspond to their capacities. This requires insurance company management to closely monitor changes in the market in order to recognize potential risks and opportunities and take appropriate steps. The main focus of insurance companies is meeting the needs of current and future policyholders. In this process, it is crucial to measure the efficiency of their operations. This paper deals with the application of the DEA method to insurance companies operating in Serbia, in order to determine their technical efficiency. Research results indicate good efficiency for some companies, or wrong allocation or inefficient use of resources in the implementation of operating activities for other companies for the observed period from 2018-2022.

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I Introduction

Insurance is a financial concept developed to manage potential risks effectively. Its objective is to provide stability for economic progress or to provide protection against unpredictable losses[4]. Although this market has shown significant profitability, the insurance industry faces considerable fragmentation and the sector gets into grip with a variety of challenges[5]. Insurance company management is expected to closely monitor changes in the market in order to recognize potential risks and opportunities and take appropriate steps[6]. The main focus of insurance companies is meeting the needs of current and future policyholders. In accordance with the current situation on the insurance market and predictions for the future, the management of insurance companies needs to develop and implement sustainable operating strategies that correspond to the capacities. In this process, it is crucial to measure the efficiency of their operations. The paper deals with the DEA method application to insurance companies operating in Serbia, in order to determine their technical efficiency.

Insurance companies constitute a vibrant sector that has developed a wide range of products to meet the needs of a wide range of consumers, including investment needs. Through the sale of insurance policies, insurance companies collect funds which they then invest in different financial instruments. It is important to note that the work of insurance companies is characterized by significant costs related to human resources, which additionally affects the complexity of measuring the efficiency of their operations. Although it is important to assess the efficiency of operations, it becomes challenging in the case of insurance companies due to their specific nature.

In its business, every company has its own principles of operation, and one of the key to financially sustainable operations is the principle of efficiency. Analysing productivity, efficiency and profitability includes the following forms of analysis[7]:

- Technical efficiency or productivity obtained as a ratio of produced quantities and production factors (employment, working time, resources);
- Economic efficiency, obtained as a ratio of income and expenses;

4 Anđelka Aničić, Ana Anufrijev, „Da li je scenario razvoja osiguranja u Srbiji optimističan", *Revizor*, Vol. 29, No. 99/2022, 81-88. *https://doi.org/10.56362/Rev2299081A*

5 Sepideh Kaffash *et al.*, „A survey of data envelopment analysis applications in the insurance industry 1993–2018", *European journal of operational research*, Vol. 284, No. 3/2020, 801-813. *https://doi.org/10.1016/j.ejor.2019.07.034*

6 Marko Milašinović, Snežana Knežević, Aleksandra Mitrović, „Upotreba alternativnih mera učinka u proceni finansijskih performansi osiguravajućih društava u Republici Srbiji", *Tokovi osiguranja*, Vol. 39, No. 2/2022, 177-201. *https://doi.org/10.5937/TokOsig2302177M*

7 Snežana Knežević, Milanka Marković, Andrijana Brown, „Measuring the efficiency of Serbian insurance companies", *Acta oeconomica*, Vol. 5, No. 1/2015, 91-105. *http://dx.doi.org/10.1556/AOecon.65.*2015.1.5

• Financial efficiency, which represents the ratio of profit to the average sum of funds employed.

Productivity, economy and profitability are partial indicators of efficiency of primordial importance. Efficiency refers to the extent to which a company successfully converts available inputs — such as assets, capital and other resources — into desired outputs - such as sales, profit and other performance indicators - reflecting the overall effectiveness of its operations. Furthermore, the partial efficiency of the company represents the ratio of one input to one output[8].

The information contained in financial statements is a central part of market information. Financial reports are of paramount importance for enhancing the functionality of the official capital market. They serve as a communication bridge between the company's management and its stakeholders, including investors and new leaders. These reports facilitate transparency and enable stakeholders to make informed decisions regarding their involvement with the company. The three key financial statements – the balance sheet, the income statement and the cash flow statement – are concerned with answering the following questions: (1) What is the company's accumulated capital at the end of the period? (2) How much profit was generated (or loss - lost capital) by the company for the observed period? and (3) What cash movements (inflows and outflows) occurred during the specified period? Financial statements are a bridge of communication between management and accountants, on the one hand, as well as investors, on the other[9].

The number of insurance companies from year to year is unchanged for the period 2018-2022, it is about 16 insurance companies in Serbia. In addition, the current situation indicates that there are four reinsurance companies. Four insurance companies deal with life insurance, and up to six companies deal with mixed insurance.

The paper relies on a systematic and comparative examination of existing scholarly literature and incorporates findings from the authors' own research. The research methodology entailed a content analysis of both primary and secondary sources, specifically focusing on a selection of 16 companies that operate in Serbia. The financial data used in the analysis were drawn from official reports published by the Business Registers Agency (Agencija za privredne registre – APR). To assess the efficiency of these insurance companies, the authors employed the DEA - CSR model. Since DEA in its current form was first introduced in 1978, researchers in a number of fields quickly recognized it as an excellent and easy-to-use methodology for modelling business processes for performance evaluation[10].

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[8] Snežana Knežević, Milanka Marković, Slađana Barjaktarović Rakočević, „Assessing Efficiency in Banking", *Industrija*, Vol. 40, No. 3/2012, 71-92.

[9] Snežana Knežević, *Finansijsko izveštavanje*, izdanje autora, Beograd, 2019.

[10] William W. Cooper, Lawrence M. Seiford, Joe Zhu, „Data Envelopment Analysis: History, Models, and Interpretations. Handbook on Data Envelopment Analysis", *International Series in Operations Research*

The rest of the paper is structured as follows: Section 2 presents a literature review of studies concerning efficiency in insurance companies with DEA model. Section 3 presents the methodology used, variables, and data. Section 4 presents and analyses the findings and discusses the results, while Section 5 concludes the paper.

II Literature review

In the field of insurance and financial literature, the evaluation of performance among insurance institutions stands as a pivotal subject, continually drawing significant research attention and interest.

Performance evaluation is indeed a crucial process in management. It serves as a means to obtain essential information for decision-making and can offer a competitive advantage by informing ongoing actions and strategies. Frequent changes in the environment, including fluctuations in interest rates and markets, variations in risk sensitivity of premium claims and growing instability in the area of currency exchange rates can sometimes show unfair characteristics[11]. The strategic activities require a solid and efficient base to yield successful results. Indeed, the efficiency of insurance companies remains a significant focus of contemporary research[12]. Sine the aim of the paper is to examine the efficiency of insurance companies in the Republic of Serbia using the DEA method, the results of similar studies conducted by researchers observating insurance companies in the Republic of Serbia and neighboring countries are presetend below.

Knežević et al. (2015)[13] used the DEA model to analyze the efficiency of insurance companies in the Republic of Serbia in the period from 2009 to 2011. During the observed period, significant fluctuations in the efficiency of insurance companies were observed, with only three insurance companies showing 100% efficiency in all three years. Using the DEA model, Micajkova (2015)[14] found that the efficiency of 11 insurance companies in North Macedonia tended to increase in the period from 2009 to 2013. Using the DEA model, Lukić et al. (2018)[15] found that only 5 out of 16 insurance companies in Serbia were

& Management Science (Eds., Cooper, W., Seiford, L., Zhu, J.), Springer, Boston, 2011, 1-39. *https://doi.org/10.1007/978-1-4419-6151-8_1*

[11] Snežana Knežević, „Faktori kvaliteta finansijskog izveštavanja osiguravajućih društava", *Računovodstvo*, Vol. 3-4, 2011, 411–427.

[12] Carlos Pestana Barros, Nazaré Barroso, Maria Rosa Borges, „Evaluating the efficiency and productivity of insurance companies with a Malmquist index: A case study for Portugal", *The Geneva Papers on Risk and Insurance-Issues and Practice*, Vol. 30, 2005, 244-267.

[13] Snežana Knežević, Milanka Marković, Andrijana Brown, A., „Measuring the efficiency of Serbian insurance companies", *Acta oeconomica*, Vol. 5, No. 1/2015, 91-105. *http://dx.doi.org/10.1556/AOecon.65.2015.1.5*

[14] Vesna Micajkova, „Efficiency of Macedonian Insurance Companies: A DEA Approach", *Journal of Investment and Management*, Vol. 4, No. 2/2015, 61–67. *http://dx.doi.org/10.11648/j.jim.20150402.11*

[15] Radojko Lukić, Miro Sokić, Dragana Vojteski Kljenak, „Analysis of insurance companies' efficiency in the Republic of Serbia", *Economic and Environmental Studies*, Vol. 18, No. 1/2018, 249-264. *https://doi.org/10.25167/ees.2018.45.14*

operating efficiently in 2016. Đurić et al. (2020)[16] attempted to analyze the efficiency of the insurance sector based on the performance analysis of 9 insurance companies using the DEA window analysis. It was found that the relative average efficiency was below 100% in all years observed, with this being particularly pronounced in the period from 2015 to 2018. The results of research by Medved & Kavčić (2018)[17] show that the Slovenian insurance industry is cost- and technically more efficient, and accordingly, a low efficiency position on the insurance market in Croatia. Fotova Čiković et al. (2024)[18] analyzed the efficiency of insurance companies in North Macedonia in the period 2018-2022. The highest efficiency level of the insurance sector was recorded in 2018, while the lowest efficiency level was recorded in 2020. During the observed period, life insurance companies achieved a higher level of relative efficiency compared to non-life insurance companies. Koprivica et al. (2025)[19] analyzed the technical efficiency of insurance companies in five Western Balkan countries in the period from 2015 to 2022 using DEA methods. It was found that insurance companies in the Republic of Serbia have the highest level of technical efficiency, while on the other hand, the lowest level of technical efficiency was recorded among insurance companies in Albania. It was also found that the level of efficiency is influenced by company size, specialization, growth, solvency and profitability.

III Data and methodology

The data applied in this research is derived from a secondary source, specifically the Annual Report of insurance companies released by The Business Registers Agency[20]. The sample encompasses 16 insurance companies that operate across Serbia. The study pertains to the time frame spanning from 2018 to 2022. In this analysis, each individual insurance company is treated as a Decision-Making Unit (DMU).

Within chapter 2, research from the observed area is presented. The remainder of this paper will present the implementation of the CRS input-oriented DEA method, a non-parametric approach, i.e., model D2 (B) was used for insurance companies operating in Serbia. For the application of the CRS model, data on capital with reserves, salary costs, and insurance operating expenses were used as inputs. As outputs, data on gross operating result and income from insurance and co-insurance premiums were utilized.

[16] Zlata Đurić, Milena Jakšić, Ana Krstić, „DEA WINDOW ANALYSIS OF INSURANCE SECTOR EFFICIENCY IN THE REPUBLIC OF SERBIA", *Economic Themes*, Vol. 58, 1/2020, 291-310.

[17] Darko Medved, Slavka Kavčič, „An empirical study of efficiency in Croatia and Slovenia insurance markets", *Economic research*, Vol. 25, No. 1/2015, 87-98. *https://doi.org/10.1080/1331677X.2012.11517496*

[18] Katerina Fotova Čiković, Violeta Cvetkoska, Mila Mitreva. „Investigating the Efficiency of Insurance Companies in a Developing Country: A Data Envelopment Analysis Perspective", *Economies*, Vol. 12, No. 6/2024, 128. https://doi.org/10.3390/economies12060128

[19] Marija Koprivica, Jelena Kočović, Tatjana Rakonjac-Antić, „What drives efficiency of insurance companies in Western Balkan countries?", *Acta Oeconomica*, Vol. 75, No. 1/2025, 19-43. *https://doi.org/10.1556/032.2025.00002*

[20] Business Registers Agency. Available *https://www.apr.gov.rs/ 20.12.2024.*

DEA method is a precisely defined procedure used to assess the efficiency of complex units within a business system that involve various inputs and outputs[21]. A DEA model can be designed to either minimize inputs or maximize outputs, depending on the desired focus[22]. DEA is a highly regarded method for determining the relative efficiency of DMUs[23]. A DMU is the designated term for business entities, such as an insurance company in this context, that undergo analysis to evaluate their efficiency using specified input and output criteria. DEA provides insights into a DMU's efficiency and inefficiency, indicating the adjustments (to reduce a certain input and/or increase a certain output) required to enhance its efficiency. Each DMU strives to optimize its weighting schemes to attain peak efficiency. Consequently, the application of diverse sets of weights leads to numerous efficient Decision-Making Units (DMUs), making it difficult to establish a consistent basis for comparison and ranking[24]. DEA model can be designed to either minimize inputs or maximize outputs[25].

In the first approach, DMU efficiency is calculated as the ratio of output to input, representing the partial efficiency of the DMU. This test is considered parametric. According to DEA conventions, the minimum number of DMUs is greater than three times the number of inputs plus output[26][27].

Efficiency is a measure of a company's success and reflects the extent to which companies make optimal use of available inputs (deposits, loans taken, engaged funds, assets and others) to produce goods or provide services and thus achieve the desired output indicators, for example, income, profit (earnings) and the like.

The partial efficiency (PE) of the *i*-th company is determined as follows:

$$PE_i = \frac{output}{input}$$

[21] A. Charnes, W.W. Cooper, E. Rhodes, „Measuring the Efficiency of Decision-Making Units", *European Journal of Operations Research*, Vol. 6, No. 2/1978, 429-444.

[22] Gordana Savić, Marko Radosavljević, Danijel Ilievski, „DEA Window Analysis Approach for Measuring the Efficiency of Serbian Banks Based on Panel Data", *Management*, Vol. 17, No. 65/2012, 5-14.

[23] Aries Susanty *et al.*, „Measuring Efficiency of Using Resource in the Production Process of Making Stamped-Batik: A DEA Approach", *Mediterranean Journal of Social Sciences*, Vol. 6, No. 5/2015, 318-327. *http://dx.doi.org/10.5901/mjss.2015.v6n5s2p318*

[24] Davood Gharakhani *et al.*, „Common weights in dynamic network DEA with goal programming approach for performance assessment of insurance companies in Iran", *Management Research Review*, Vol. 41, No. 8/2018, 920-938. *https://doi.org/10.1108/MRR-03-2017-0067*

[25] Nemanja Lekić *et al.*, „The efficiency analysis in small wineries in the Republic of Serbia", *Economics of Agriculture*, Vol. 65, No. 4/2018, 1529-1544. https://doi.org/10.5937/ekoPolj1804529L

[26] M. Vassiloglou, D. Giokas, „A study of the relative efficiency of bank branches: an application of data envelopment analysis", *Journal of the operational research society*, Vol. 41, No. 7/1990, 591-597. *https://doi.org/10.1057/jors.1990.83*

[27] R.G. Dyson *et al.*, „Pitfalls and protocols in DEA", *European Journal of operational research*, Vol. 132, No. 2/2001, 245-259. *https://doi.org/10.1016/S0377-2217(00)00149-1*

This concept of efficiency is frequently used by financial analysts to assess key performance dimensions such as productivity, economic efficiency, and profitability. Emphasizing financial efficiency plays a crucial role in evaluating the general well-being and long-term viability of a company or economic entity. This focus on financial efficiency is integral to assessing the overall health and sustainability of a company or economic entity. Ratio coefficients as logically connected items from financial statements are often used as measures of business efficiency but show partial efficiency. This is a parametric approach to efficiency measures.

O'Donnell[28] defines the total efficiency factor (TE) as the ratio of each PE to the maximum PE value of the *n* observed companies.

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

The second approach is non-parametric, acknowledging that assessing the efficiency of a unit, particularly a non-profit entity, often requires consideration of multiple inputs and outputs of various natures (financial, technical, technological, social, etc.), which are measured in different units. In this non-parametric context, we employ the DEA method for measuring efficiency. The following format is used to apply DEA efficiency:

DEA Efficiency = Weighted Sum of Output / Weighted Sum of Input

CCR-Model was introduced by Charnes et al.[29]. In the CCR model, "the technical efficiency calculated is composed of both pure technical efficiency and scale efficiency"[30]. The CRS models assume constant returns to scale (The Constant Returns to Scale Model). If the condition is added that

$$\sum_{j=1}^{n} \lambda_j = 1$$

then the models are obtained, known as BCC DEA models[31] or VRS (The Variable Returns to Scale Model) models, depending on the literature used.

[28] C.J. O'Donnell, „An aggregate quantity framework for measuring and decomposing productivity change", *Journal of Productivity Analasys*, Vol. 38, 2012, 255–272. https://doi.org/10.1007/s11123-012-0275-1
[29] A. Charnes, W.W. Cooper, E. Rhodes, „Measuring the Efficiency of Decision-Making Units", *European Journal of Operations Research*, Vol. 6, No. 2/1978, 429-444.
[30] Nand Kumar, Archana Singh, „Efficiency analysis of banks using DEA: A review", *International Journal of Advance Research and Innovation*, Vol. 1, 2014, p. 121
[31] R.D. Banker, A. Charnes, A., W.W. Cooper, „Some models for estimating technical and scale inefficiencies in data evelopment analysis", *Management Science*, Vol. 30, No. 9/1984, 1078-1092.

Basic DEA models come in various variants with specific constraints, including those related to weight restrictions or based on the type of input or output variables, among other factors. Inputs could be things like labor, capital, or resources, while outputs could be production, revenue, or services provided. Our focus is on two models.

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

Charnes et al. (1978) proposed (known as the CCR ratio model) that for each DMU_k, $k = 1, 2,...,n$, an optimization problem of the following form should be solved:

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

subject to conditions

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

where h_k is the relative efficiency of the k-th DMU, n – the number of observed DMU, m is the number of inputs and s is the number of outputs, u_r weighting coefficient for the output r and v_i weighting coefficient for the input i. The weighting coefficients u_r and v_i are unknown in the model that are determined by optimization and construct a virtual input and a virtual output.

Based on the provided information, it can be concluded that $0 \leq h_k \leq 1$.

If h_k equals 1, the k-th DMU is considered relatively efficient, meaning it is no other DMU can achieve a higher output value for a given input.

If h_k is less than 1, the k-th DMU is considered relatively inefficient and the value h_k shows by what percentage the k-th unit should reduce its inputs.

The weighting coefficients u_r and v_i indicate the relative importance of individual inputs and outputs for each DMU, so that each DMU is as efficient as possible.

This model is non-linear, non-convex with linearly decomposed objective function and constraints.

MODEL D2. Model D1 can be reduced to a linear model as follows

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

with conditions

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

$u_r \geq \varepsilon$, $v_i \geq \varepsilon$, where ε is a small positive value, i.e. $\varepsilon > 0$, r = 1,2,…, s, j = 1,2,…,m,

In Model D2, the objective is to maximize the virtual output while ensuring that the virtual input is equal to 1.

The dual linear programming problem for model (A) can be described as follows:

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

under the conditions that

$$\sum_{j=1}^{n} \lambda_j x_{ij} \leq \theta x_{ik}, i = 1,2,...,m, \ \sum_{j=1}^{n} \lambda_j y_{rj} \geq y_{rk}, r = 1,2,...,s, \ \lambda_j \geq 0, j = 1,2,...,n.$$

IV Research results and discussions

The overall efficiency of individual insurance companies for each year was computed using Excel Solver by configuring the relevant parameters and constraints in accordance with model D2 (B). The outcomes are presented in Table 1.

In order to interpret the obtained results, it is necessary to point out at the beginning that the efficiency rating, which is expressed relatively, indicates the relative position of insurance companies within the observed sector I for each year. If k-DMU (the insurance company) is relatively efficient, and if C_k is below 100, k-DMU (the insurance company) is relatively inefficient.

Table 1. Efficiency rating of insurance companies for the period from 2018-2022, individual and average

Insurance company	Efficiency rating					Average efficiency
	2018	2019	2020	2021	2022	
AMS insurance	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
DDOR Novi Sad	100.00%	96.33%	100.00%	96.05%	100.00%	98.48%
Dunav Insurance	100.00%	91.49%	95.26%	87.05%	77.75%	90.31%
Generali insurance	100.00%	100.00%	100.00%	98.91%	96.02%	98.99%
Globos insurance	100.00%	47.36%	78.34%	100.00%	100.00%	85.14%
Grawe insurance	100.00%	100.00%	97.69%	94.33%	92.50%	96.90%
Merkur insurance	87.41%	90.02%	94.77%	92.20%	81.95%	89.27%
Milenijum insurance	100.00%	92.15%	100.00%	98.69%	88.00%	95.77%
OTP insurance	88.30%	71.16%	82.29%	86.03%	100.00%	85.56%

Sava non-life insurance	83.40%	67.17%	70.39%	60.38%	78.99%	72.06%
Sava life insurance	53.57%	60.43%	67.64%	71.02%	78.89%	66.31%
Sogaz	91.32%	88.51%	73.15%	79.29%	78.25%	82.10%
Triglav insurance	90.16%	70.40%	74.20%	67.81%	78.15%	76.14%
Uniqa non-life	93.72%	73.96%	68.47%	69.91%	87.16%	78.64%
Uniqa life	82.03%	76.53%	67.01%	70.75%	57.84%	70.83%
Wiener städtische insurance	93.67%	100.00%	100.00%	100.00%	100.00%	98.73%
Average value	91.47%	82.84%	85.58%	85.78%	87.22%	86.58%

Source: authors based on data from insurance companies' financial reports

The results of the DEA analysis of the efficiency of insurance companies in Serbia for the period from 2018 to 2022 show clear differences between the companies observed. AMS Insurance stands out as the only company that maintained the maximum efficiency level (100%) throughout the analyzed period, which indicates a consistent optimal use of available resources in generating production values. In addition, Generali Versicherung, Wiener Stadtische Versicherung and DDOR Novi Sad have high efficiency scores, with slight fluctuations but no significant deterioration in overall performance. On the other hand, several insurance companies show a significant decline. For example, Dunav Insurance, Grave Insurance, Merkur Insurance and Milenijum Insurance record a constant decline in efficiency in 2021 and 2022. As for the average efficiency of insurance companies during the five-year period observed, only AMS Insurance operated with an efficiency of 100%. Generali insurance, with an average efficiency of 98.98%, is at the second place, while at the third place is Wiener städtische insurance (with an average efficiency of 98.73%). The lowest average efficiency in the period from 2018 to 2022 was recorded at the insurance company Sava life insurance and amounted to 66.31%.

In addition to determining the efficiency of insurance companies by individual years of operation, it is also necessary to look at its trend during the observed period. As stated in the third part, chain indices will be used for these purposes in the paper. Table 2 shows the value of the chain indices.

Table 2: Chain indices

Insurance companies	Chain indices			
	2019/2018	2020/2019	2021/2020	2022/2021
AMS insurance	100.00	100.00	100.00	100.00
DDOR Novi Sad	96.33	103.81	96.05	104.11

Insurance companies	Chain indices			
	2019/2018	2020/2019	2021/2020	2022/2021
Dunav insurance	91.49	104.12	91.38	89.32
Generali insurance	100.00	100.00	98.91	97.08
Globos insurance	47.36	165.42	127.65	100.00
Grawe insurance	100.00	97.69	96.56	98.06
Merkur insurance	102.98	105.27	97.29	88.89
Milenijum insurance	92.15	108.52	98.69	89.17
OTP insurance	80.58	115.65	104.55	116.23
Sava non-life insurance	80.54	104.80	85.79	130.81
Sava life insurance	112.81	111.92	105.00	111.07
Sogaz	96.91	82.65	108.39	98.69
Triglav insurance	78.08	105.40	91.39	115.25
Uniqa non-life insurance	78.92	92.57	102.10	124.68
Uniqa life insurance	93.29	87.57	105.58	81.75
Wiener städtische insurance	106.76	100.00	100.00	100.00

Source: authors based on data from Table 1

As can be seen from the previous table, the efficiency of most insurance companies varied from year to year. Only at the insurance company AMS insurance is the level of efficiency constant during the observed period, that is, at the insurance company Wiener städtische insurance the level of efficiency is constant during the last 4 years. The greatest decrease and increase in efficiency during the observed five-year period was recorded at the insurance company Globos insurance. Namely, this insurance company recorded a decrease in efficiency of 52.64% in 2019 compared to 2018, and already in the following year (2020) an increase in efficiency of 65.42% was recorded.

As can be seen from Figure 1, the average efficiency of the insurance sector in the Republic of Serbia fluctuated during the period under review. In 2019, there was a significant decline in the average efficiency of the insurance sector, followed by an upward trend. In 2018 and 2019, the efficiency of seven insurance companies was below the average efficiency at sector level. In 2020 and 2022, half of the insurance companies had an efficiency that was below the average efficiency at sector level. In 2021, six insurance companies had an efficiency that was below the sector average. In all five years observed, four insurance companies (Sava non-life Insurance, Sava Life Insurance, Triglav Insurance and Uniqa Life) had an efficiency that was below the average efficiency at sector level.
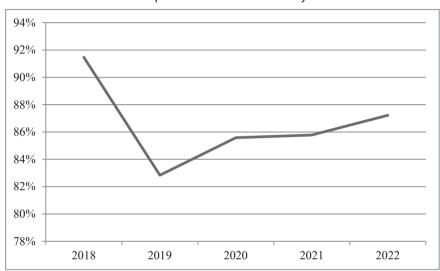
Figure 1: Average efficiency of the insurance sector in the Republic of Serbia in the period from 2018 to 2022. year

Source: authors based on data from Table 1

The study shows that the efficiency of insurance companies in Serbia can be improved. In order for insurance companies to improve their efficiency in the future, it is necessary to manage assets, employees, capital, but also business income and profits as efficiently as possible, which can be achieved by applying modern cost management concepts[32].

V Conclusion

The paper aims to analyze the efficiency of insurance companies in the Republic of Serbia by applying the DEA method. The investigation revealed that the efficiency of insurance companies varies significantly over the observed period, with only a small number of insurance companies having an efficiency of 100% in each of the observed years. In other words, the majority of them operate at less than 100% efficiency, i.e. inefficiently. This confirms the results of previous studies that the efficiency of insurance companies in the Republic of Serbia can still be significantly improved.

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[32] Radojko Lukić, Miro Sokić, Dragana Vojteski Kljenak, „Analysis of insurance companies' efficiency in the Republic of Serbia", *Economic and Environmental Studies*, Vol. 18, No. 1/2018, 249-264. *https://doi.org/10.25167/ees.2018.45.14.*

TOKOVI OSIGURANJA

If a system exhibits significant inefficiency and lacks comprehensive regulation while operating within an outdated framework, there may be a need for adjustments and restructuring activities. These actions can be prompted by the rising competition in the insurance sector, with the goal of enhancing overall system efficiency. The results of the research can usefully serve company managers and other interest groups (investors) who want insight into the efficiency of the observed insurance companies. Based on the received efficiency data, it was identified for which companies and in which periods the efficiency was unsatisfactory, which certainly affected the financial viability of the observed companies. Productivity and efficiency are essential metrics to realize companies' goals and diagnose critical points for performance improvement.

The efficiency of DEA and its suitable applications strongly rely on the quality and suitability of the dataset used as an input for the productivity model. It's important to note that while there are various DEA models available, certain characteristics of data may render them unsuitable for the application of DEA models. Since the paper applies the CCR model of DEA analysis, which assumes that the assumption of constant returns to scale is met, i.e. that all observed companies operate at the optimal volume of activity (which is often not the case in practise), the results of the efficiency assessment should be viewed with a certain degree of caution.

In future research, there is an expectation to include additional input and output variables as measures of efficiency for insurance companies. Furthermore, the possibility of extending the research to include Islamic insurance in various other countries is also being considered. Also, future research should also investigate which factors influence the degree of efficiency.

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