EFFICIENCY ANALYSIS OF THE RISK-BEARING SECTOR IN SERBIA

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Abstract - The risk-bearing sector plays a key role in Serbia's financial system by managing and redistributing risks, safeguarding households and enterprises, and holding a significant market share. Despite its importance, the sector remains underdeveloped compared to EU countries, reflecting low living standards, weak insurance culture, and limited awareness of risk protection benefits. This paper evaluates the efficiency of Serbian insurance and reinsurance companies from 2019 to 2021 using an output-oriented BCC Data Envelopment Analysis (DEA) model. This method allows benchmarking across firms and identifying potential improvements in outputs such as premium income, investment returns, and net profit. Results indicate that, despite the economic disruptions caused by the COVID-19 pandemic, the sector maintained relatively high efficiency levels. While several firms consistently operated on the efficiency frontier, others showed notable performance gaps. Improving efficiency is essential not only for company-level competitiveness but also for strengthening the resilience of Serbia's financial system and supporting sustainable economic growth.

Keywords - Risk-Bearing Sector; Efficiency; Data Envelopment Analysis (DEA); Output-Oriented BCC Model

I. INTRODUCTION

The risk-bearing sector comprises institutions that assume, manage, and redistribute financial risks, thereby contributing to economic stability and resilience. In the Serbian context, this sector plays a pivotal role in safeguarding both households and enterprises against unforeseen events, while maintaining a significant share in the country's financial market. Insurance companies represent a significant segment of the financial market and manage large amounts of capital. In terms of development level, it is significantly below the average of European Union member states. This situation in the insurance market is partly due to the low standard of living, but also to a lack of insurance culture and insufficient awareness of the benefits of insurance. The development of the insurance market is an indicator of a country's overall level of development. The insurance sector contributes to economic growth and national prosperity in various ways. At the macro level, it helps strengthen the efficiency and resilience of the economy by enabling risk transfer. At the micro level, it provides benefits across all areas of daily life. Insurance helps individuals minimize the financial impact of unexpected and undesirable future events and allows them to organize their business and personal lives with greater certainty.

Evaluating business performance is one of the primary tasks of every company, as it determines the degree to which defined goals have been achieved and enables comparison with other companies in the same market. Considering the multifaceted role of insurance companies in the national economy, regular monitoring of their financial performance and assessment of their financial position is essential. To determine efficiency, the Data Envelopment Analysis (DEA) method was used, as it is particularly suitable in cases where the efficiency of a large number of decision-making units needs to be assessed. DEA compares each decision-making unit with the best-performing ones, aiming to identify the best virtual decision-maker for each real unit. At the same time, the increasingly frequent application of the DEA model in finance(Marcikic Horvat et al., 2022; Milenković et al., 2022) may, as a result, indicate which financial institutions are achieving a higher level of efficiency in business.

The aim of this paper is to analyse the efficiency of insurance companies operating in the Serbian market. Insurance companies have faced constant pressure from various crises over the years, including economic, political, and most recently, the COVID-19 health crisis. Given the continuous growth of Serbia's insurance sector, it is crucial to monitor the impact of the health crisis on this trend, observe any potential changes, and evaluate the sector's performance. Accordingly, special attention will be given to interpreting the results obtained through the application of the DEA method.

II. LITERATURE REVIEW

Efficiency analysis in the insurance industry has become an increasingly important topic, particularly in the context of emerging markets like Serbia. Efficiency in this context is generally understood as a firm's ability to use its resources—such as labor, capital, and operational costs—to generate optimal outputs, including premiums, investment income, and claims servicing. The most frequently used methodological frameworks in this area include Data Envelopment Analysis (DEA), Stochastic Frontier Analysis (SFA), and multi-criteria decision-making methods like AHP and TOPSIS. These approaches help researchers measure technical and scale

efficiency, assess performance gaps, and identify areas of improvement across firms.

The Serbian insurance sector is moderately concentrated and evolving, with a growing life insurance market and increasing importance placed on investment performance. Several studies have examined efficiency among Serbian insurers, with consistent findings that many companies operate below the efficiency frontier. For instance, Knežević, Marković, and Brown (2015) applied DEA to Serbian insurers and identified significant disparities in efficiency levels across companies. Their findings emphasized the importance of benchmarking and resource optimization. A more nuanced approach was taken by Mandić et al. (2017), who applied fuzzy AHP and TOPSIS to evaluate efficiency based on weighted financial indicators. Their research found that investment performance and the life insurance segment significantly influenced overall rankings, highlighting the role of strategic investment management in driving efficiency.

Another notable study by Lukić, Sokic, and Vojteski Kljenak (2018) also used DEA to analyze 16 Serbian insurers and found that 11 of them operated inefficiently. The authors stressed the need for better cost control, improved human capital management, and more effective use of operating income. While these studies provided useful snapshots, they were largely static in nature. Addressing this, Đurić, Jakšić, and Krstić (2020) employed a DEA Window Analysis approach to assess dynamic efficiency over the 2007–2018 period. They reported that technical, pure technical, and scale efficiency levels all remained below the optimal threshold across the years, with declines observed after 2015. This long-term view revealed structural inefficiencies that are not visible in cross-sectional studies.

More recently, Pjanić, Mitrašević, and Luković (2023) shifted the focus toward profitability rather than pure efficiency, using panel data analysis to examine internal determinants of performance among Serbian life insurance companies between 2015 and 2021. They found that higher operating margins and liquidity ratios were positively associated with profitability, while higher expense ratios and financial leverage had negative impacts. Though not strictly an efficiency analysis, their findings align with previous DEA-based research by emphasizing the importance of internal financial discipline.

To contextualize the Serbian findings within the broader literature, numerous global studies offer both methodological advancements and sectoral benchmarks. One of the most influential reviews in this field is Eling and Luhnen (2010) who systematically surveyed 80 studies using DEA, SFA, and other frontier methodologies in insurance. Their work outlined common model specifications, input/output selections, and recommended best practices for robustness checks. Cummins et al. (2010) used DEA to examine economies of scope in the U.S. insurance industry and found that diversification across life and non-life insurance lines did not always yield efficiency gains. Similarly, Segovia-Gonzalez et al. (2009) applied DEA to evaluate risk, cost, and revenue efficiency, incorporating risk measures as inputs—a relevant consideration for insurance firms managing underwriting risks.

Other notable contributions include Sinha (2015), who employed a dynamic DEA model on Indian life insurers, allowing for intertemporal efficiency measurement that captures performance trends over time. Tayebi et al. (2024) enhanced the DEA framework by incorporating undesirable outputs—such as claims paid—through a slacks-based measure (SBM) DEA model, offering a more realistic view of insurance production processes. Malya and George (2025) conducted a three-stage DEA to decompose operational, investment, and capital allocation efficiencies, which is especially relevant for analyzing multifaceted financial institutions.

III. METHODOLOGY

DEA (Data Envelopment Analysis) is a mathematical programming method used for efficiency evaluation. Data Envelopment Analysis is a popular non-parametric efficiency analysis method that has been successfully applied across various fields and at different levels. To determine the efficiency of different decision-making units (DMUs), this method is designed to handle a larger number of input and output variables. Unlike parametric statistical methods, DEA compares the efficiency of each entity with the highest achieved level of efficiency, rather than with the average. It is a non-parametric method because it does not require any a priori assumptions about the analytical form of the observed inputs and outputs. A significant advantage of the DEA method is that it allows for the use of many different inputs and outputs in the analysis, which can be expressed in various types of units or measures (Marcikić Horvat et al., 2023).

If we consider a system consisting of n decision-making units (DMUs), m inputs, and s different outputs, efficiency, in the general case, is calculated using the DEA method as the ratio of the weighted sum of outputs to the weighted sum of input parameters, which should be maximized, according to the following formula:

$$max \frac{\sum_{r=1}^{s} u_r y_{r0}}{\sum_{i=1}^{m} v_i x_{i0}}$$

$$\frac{\sum_{r=1}^{s} u_r y_{r0}}{\sum_{i=1}^{m} v_i x_{i0}} \leq 1, k = 1, \dots, n \qquad (2)$$

$$u_r, v_i \geq 0,\ r = 1, \dots, s,\ i = 1, \dots, m$$

Where y_{rj} and x_{ij} represent the r-th output and i-th input, respectively, for the j-th decision-making unit, while u_r and v_r denote the weight assigned to the r-th output and the i-th input, respectively.

To assess the efficiency of the insurance companies included in the analysis, it is necessary to determine which input and output variables are appropriate to obtain relevant parameters. Input variables refer to those variables that are invested and consumed during the reproduction process to generate output variables. From the above, it follows that there is a need to express input and output variables in monetary terms. To that end, and considering the requirement for publicly available financial reporting and its wide accessibility to external users, the analysis was conducted based on data from the balance sheet and the income statement, where:

- Input variables included: receivables, placements and cash, total assets, core and other capital (balance sheet items), and operating (functional) expenses (income statement item).
- Output variables included income statement items: premium and co-insurance revenue, investment income from insurance funds, and net profit.

The first step in the Data Envelopment Analysis (DEA) process is the definition and selection of decision-making units (DMUs). In this case, the decision-making units are the insurance and reinsurance companies operating in the Republic of Serbia. Accordingly, the analysis includes 16 companies engaged in insurance activities and 4 companies engaged in reinsurance activities. This is in accordance with the defined aim of the paper to analyse insurance companies operating in the Serbian market during the period from 2019 to 2021.

The second step in DEA process is the model selection. The basic DEA model assumes constant returns to scale and is known as the CCR model. This model is used to measure overall technical efficiency. The underlying assumption of this model is that decision-making units (DMUs) operate under optimal conditions in a perfectly competitive market, which is a theoretical construct. To overcome this limitation, the BCC model was developed. It assumes variable returns to scale and provides results that are more relevant for markets characterized by imperfect competition. This model is used to calculate so-called pure technical efficiency. DEA models (the CCR and BCC models) can be either input-oriented or output-oriented. Input-oriented models are used to provide recommendations to inefficient units in terms of the required reduction in inputs, while output-oriented models provide recommendations in terms of the necessary increase in outputs in order to achieve an acceptable level of efficiency (Kočišová K, 2013). In the analysis of the operational efficiency of the insurance sector in the Republic of Serbia, the output-oriented BCC model was applied. Output orientation was chosen because it provides insight into how outputs can be increased to improve efficiency.

IV. RESULTS

By calculating and analysing the efficiency scores, a clear answer can be obtained to the question of whether high absolute values of these balance sheet items also imply high operational efficiency. The following table presents the results obtained through the application of Data Envelopment Analysis, using the output-oriented BCC model, implemented in the MaxDEA 8 Basic software.

	Efficiency coefficient		
Insurance companies (DMU)	2019	2020	2021
AMS	1	1	1
DDOR Novi Sad	1	1	1
DDOR Reinsurance	1	1	1
Dunav	1	1	1
Dunav reinsurance	0.8648699	1	0.81159 7325
Generali insurance Serbia	1	1	1
Generali reinsurance Serbia	1	1	1
Globos insurance	1	0.96166 4328	1
Grawe	1	1	1
Merkur insurance	1	1	1
Milenium	1	1	0.96571 1778
OTP insurance	1	1	1
Sava non-life insurance	0.9970742	1	1
Sava life insurance	1	1	1
Sogaz	1	1	1
Triglav	1	1	0.97011 6498
UNIQA non-life insurance	1	1	1
UNIQA life insurance	1	1	1
Wiener reinsurance	0.4233603	0.38862 8904	0.32457 3027
Wiener Stadtische	0.9038308	1	1
average	0.9594568	0.96751 4662	0.95359 9931

Table 1. Efficiency coefficients in the Serbian insurance sector from 2019 to 2021

In 2019, out of 16 insurance companies and 4 reinsurance companies, 14 insurance companies and 2 reinsurance companies recorded 100% efficiency. Among the insurance companies, Sava Non-Life Insurance and Wiener Stadtische showed slightly lower efficiency levels of 0.99707424 (99.71%) and 0.903830788 (90.38%), respectively. In addition to them, Dunav Reinsurance and Wiener Reinsurance also recorded lower efficiency levels, at 0.864869917 and 0.423360287, respectively.

Among all (re)insurance companies, Wiener Reinsurance had the lowest efficiency score. The average efficiency of the Serbian insurance sector in 2019 was 0.959456762. During this period, all companies except Dunav Reinsurance, Wiener Reinsurance, and Wiener Stadtische operated with above-average efficiency.

In 2020, the list of fully efficient (re)insurance companies included 15 insurance companies and 3 reinsurance companies, which is one more insurance and one more reinsurance company compared to 2019. At the bottom of the list, in terms of efficiency, was Wiener Reinsurance with a score of 0.388628904 (38.86%), indicating a negative trend and a deterioration in performance compared to the previous year. Globos Insurance had a slightly lower efficiency score than 100%, at 0.961664328 (96.17%), representing a decline in efficiency relative to 2019.

In contrast to Globos Insurance, Dunav Reinsurance, Sava Non-Life, and Wiener Stadtische improved their operational efficiency in 2020 compared to 2019. The average efficiency of the Serbian insurance sector in 2020 increased to 0.967514662. All companies that had 100% efficiency operated above the sector average.

In 2021, 14 insurance companies and 2 reinsurance companies again achieved full efficiency, just as in 2019. Dunav Reinsurance experienced a decline in efficiency compared to the previous two years, with a score of 0.811597325. It was followed by Milenijum Insurance with 0.965711778, and Triglav with 0.970116498, both of which dropped from their previously perfect efficiency levels in 2019 and 2020. Wiener Reinsurance recorded the lowest efficiency score in 2021, at 0.324573027, which was the lowest not only in comparison to the previous year but also across all companies and all years observed.

The average efficiency of the Serbian insurance sector in 2021 was 0.953599931. During this period, all companies with 100% efficiency, as well as all except Milenijum and Triglav, operated above the average.

V. CONCLUSION

The development level of financial markets is widely recognized as a key indicator of a country's overall economic progress. In the case of the Republic of Serbia, as a developing country, the insurance sector has faced notable challenges—particularly since the global financial crisis of 2008. This period has been marked by economic instability, weakened growth, increased reliance on imports, and depreciation of the national currency. These factors have impacted the financial system and, by extension, the performance of financial institutions, including insurance companies.

The insurance sector plays a crucial role in supporting economic development by facilitating risk management and promoting financial stability. Its core function—to identify and assume risks through customized offerings—supports the efficient allocation of resources. Without a functioning insurance system, national economies would face increased uncertainty and volatility. As economic development increases, so does the relevance and impact of the insurance industry, making it a contributor to broader societal welfare. Consequently, the operational efficiency of insurance companies has important implications for the health and stability of the national economy.

Over the past five decades, the global insurance industry has experienced significant transformation, driven by technological advancements and increasing demand for risk protection. Insurance has evolved into an essential economic activity and an integral part of both corporate and individual financial planning. In this competitive and dynamic environment, insurance companies must demonstrate adaptability, professionalism, and strategic responsiveness. Efficient performance monitoring, especially through advanced analytical tools, has become essential for identifying inefficiencies and improving decision-making.

Among these tools, Data Envelopment Analysis (DEA) stands out as one of the most frequently applied non-parametric methods for assessing relative efficiency. DEA allows for the evaluation of performance by comparing input and output variables across decision-making units (DMUs), while identifying best practices that can serve as benchmarks for others in the industry. Its widespread application encourages performance improvement across the entire sector.

This study applied an output-oriented BCC DEA model to assess the efficiency of insurance companies operating in Serbia over the period from 2019 to 2021. Output orientation was selected to identify how outputs—such as premium income, investment returns, and net profit—can be increased to enhance overall efficiency.

Despite the adverse effects of the COVID-19 pandemic, including a drop in premium income, rising claims, and higher operating costs, the results indicate that the Serbian insurance sector maintained a relatively high level of efficiency throughout the observed period. The highest potential for output growth, under the assumption of full efficiency, was observed in 2021, with total outputs projected at 121,318,267.81 thousand dinars. The largest necessary adjustment was in premium and co-insurance income (3,124,033.28 thousand dinars), followed by investment income (141,174.07 thousand dinars), and net profit (104,730.46 thousand dinars).

These required adjustments reflect the ongoing recovery from the pandemic's negative economic impact. However, a notable positive trend has emerged: increased public awareness regarding the importance of insurance. In the long run, this is likely

to lead to sustained growth in premium revenues and profitability across the sector.

Ultimately, improving the efficiency of insurance companies is essential not only for firm-level competitiveness but also for strengthening the resilience and effectiveness of the financial system. The findings of this study highlight areas where targeted improvements in outputs could enhance performance and reinforce the contribution of the insurance sector to Serbia's economic development.

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