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ASSESSING EFFICIENCY PERFORMANCE IN THE SERBIAN INSURANCE INDUSTRY WITH DEA MODEL

Abstract: The insurance industry develops financial institutions and reduce uncertainties by improving financial resources. The main goal of this paper is to assess the efficiency performance of Serbian insurance companies and to check the influence of the important profitability drivers on the efficiency scores in terms of the whole insurance market. As the market develops For the rapidly developing market authors decide to find a tool for assessing efficiency performance in the insurance industry. In some paper we found that the authors measure efficiency of insurance companies, but we decided to use two-phase analysis, DEA in the first, and a Tobit regression in the second phase.
Keywords: DEA model, incurance industry, efficiency

1. INTRODUCTION

Insurance greatly contributes to the overall economic growth and development of the society by providing stability to the functioning of process. Also, insurance has emerged as an approach of safeguarding the interest of people from loss and uncertainty. Accordingly, the importance of insurance companies lies in the stability of financial systems primarily because they are significant investors in financial markets, because they securing the financial stability of insurance service users by insuring their risks and because there are growing linkages between insurance companies and banks (European Central Bank, 2009).

Insurance companies as the most important actors at the insurance market operate within a highly competitive environment. In order to be prosperous in such business conditions they must carry out their activities efficiently (Grmanova & Strunz, 2017). As the market develops rapidly, it becomes an imperative to find a tool that will enable managers to identify the companies with the best position to respond and thrive in such conditions. Therefore, assessing efficiency performance in the insurance industry remains an objective of considerable interest (Yang, 2006).

There are few papers that pay attention to measuring efficiency of insurance companies, but none deals with a two-phase analysis, using DEA in the first, and a Tobit regression in the second.

The paper is organized in three sections. After the introduction, which accentuates the main research questions and objective, the second section on literature review presents the results from previous relevant researches addressing application of Two-stage Data Envelopment Analysis (DEA) in insurance. The first part of third section deals with model and data explanation. The results of DEA and Tobit model are presented in the final section together with the main conclusion and ideas for further research.

2. LITERATURE REVIEW

Since the efficiency of insurance companies is the important determinant of the efficiency of national economy, many researchers have been interested in this topic lately. The first part of this section presents the review of papers dealing with the recent efficiency analysis of insurance companies' in the Republic of Serbia. Furthermore, literature review of the applied Two-stage DEA model will be presented.

One of the first applications of DEA model to asses the efficiency of Serbian insurance sector is presented in the paper Stepić & Stosić (2012). Their research present the results of a relative efficiency evaluation, performed on the data collected from 19 insurance companies which operate in Serbia, covering a reference period of two consecutive years – 2009 and 2010. The output oriented constant return to scale (CRS) DEA method was used to evaluate relative efficiency of each insurance company from its operating and financial aspects. Input variables were: insurance costs, capital and reserves, number of employees, number of insurance types and number of branches. Total income was used as output.

Knežević et al. (2015) applied input oriented CRS DEA model to asses the efficiency of insurance companies on Serbian market from 2009 until 2011. They used data on commercial assets, wages, salaries and other personnel costs, and equity as inputs, and business functional revenue before tax for the output.

Mandić et al. (2017) proposed a fuzzy multi-criteria model that facilitate the assessment of insurance companies' efficiency. Fuzzy Analytic Hierarchy Process (FAHP) and Technique for Order Performance by Similarity to Ideal Solution (TOPSIS) were used for building the proposed model for companies operating within the insurance sector in Serbia in the period from 2007 to 2014. In the first stage, priority weights of criteria were defined by using the FAHP, while in the second phase the insurance companies were ranked using the TOPSIS method.

Lukić et al. (2018) analysed the insurance companies' business efficiency in Serbia in 2016 using CRS input oriented DEA model. The input variables were: total assets, number of employees and capital. Output variables were: operating income and net profit. Results showed that out of the 16 insurance companies, 11 are inefficient. In order to improve their business, it is necessary to more efficiently manage their operating income and profits.

Stanković et al. (2018) also used input oriented CRS DEA model to examine and evaluate the efficiency of Serbian nonlife insurance companies during the period 2014–2016. On the side of output two variables were used: investment income and gross written premium. Labour costs, equity capital and debt capital were used as input variables. Findings of this study indicate that almost three-quarters of insurance companies operated inefficiently, while the main cause of inefficiency lies in high labour costs.

Mitrović et al. (2020) conducted the empirical research, using the 2014-2018 data for 16 insurance companies in Serbia, on the efficiency of life, non-life and mixed insurers, by means of the network DEA method. Results showed that mixed insurers in Serbia are more efficient than specialized insurers, where non-life insurers are the least efficient. Also, technical efficiency in Serbia has declined in 2017 and 2018, which corresponds to deterioration of investment efficiency.

Đurić et al. (2020) looked at the insurance sector efficiency through the performance analysis of nine selected insurance companies in the period 2007-2018, using output oriented CRS and variable return to scale (VRS) DEA window analysis. Input variables were: insurance number, administration costs and acquisition costs. Output variables were: investment income and claims settled. Results showed very poor performance of the insurance sector as a whole, because in all years of the observed period the relative average efficiency (technical, pure technical and scale efficiency) was below 100%, especially in the period 2015-2018.

There are numerous studies that use regression analysis in further defining the efficiency of insurance companies as the second stage of the DEA analysis.

Grmanova and Strunz (2017) determine the relationship between technical efficiency and profitibility of 15 commercial insurance companies in Slovakia using a Tobit regression. They expressed profitability of insurance companies by such indicators as ROA, ROE and the size of assets.

Huang and Eling (2013) identify four drivers of efficiency (size, profitability, solvency and ownership form) using a regression model in the second stage of DEA analysis in four the fastest growing markets in the world – the BRIC countries. The authors conclude that lower ratio of claims paid to premiums cannot improve firms efficiency, while sustainable and independent ownership structure does improve efficiency.

Yakob et al. (2014) applied the Tobit model to indentify exogenous factors impacting efficiency of insurance companies in Malaysia. The results show the statistical significance of size and organizational form.

Jalaoudi (2019) used panel data of 22 insurance companies operating in Jordan over the period 2000-2016. The results indicate that owner`s equity are among the most important internal determinants of relative technical efficiency and there is a significant correlation between type, size and return on assets and efficiency scores.

Borges et al. (2008) state that large and quoted life insurance companies are more efficient based on the analysis of Greek life insurance companies over the period 1994-2003.

3. METHODOLOGY AND DATA

Data Envelopment Analysis (DEA) is currently one of the most popular quantitative technique for efficiency analysis, where efficiency is observed as relation between selected output and input variables. DEA is based on linear programming models and can be successfully applied in various areas, both on micro and macro economic levels. In

this chapter, insurance companies, which operate in Serbia, will be used as Decision Making Units (DMU) in the analysis. This method compares the efficiency of each DMU with the maximal achieved efficiency score in the observed sample. DEA is a non-parametric quantitative method because it doesn't require a prior assumption about the analytical form of input and output variables. The results of the DEA model are relative efficiency measures, as they depend on selected sample, mainly on the number of DMUs in the model and selection of input and output variables. The choice of DEA model orientation depends on whether decision-makers have more influence on improving input or output levels. Recently, numerous variants of DEA model are developed. In this chapter, the output-oriented DEA model with a variable return to scale has been used to examine the efficiency of insurance companies on the Serbian market. 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) of linear programming for each insurance company and each period of time:

$$\max \phi \qquad (1)$$

$$s.t. \sum_{j=1}^{n} x_{ij}\lambda_j \leq x_{io} \quad i = 1, 2, \dots, m;$$

$$\sum_{j=1}^{n} y_{rj}\lambda_j \geq \phi y_{ro} \quad r = 1, 2, \dots, s;$$

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

$$\lambda_j \geq 0$$

where n is the number of DMUs (Decision Making Units – countries in our case) and DMU_o represents the country under evaluation. Assume 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 insurance companies in Serbia over the period of five years, from 2015 until 2019. The data were retrieved from the Annual Reports published at the website of The National Bank of Serbia[1] for the abovementioned time period. Based on the comperhesive analysis of previous researches and the main objective of this study, two output and two input variables were selected for DEA model. Profit and total premiums of insurance and reinsurance were used as output variables, while equity and claims paid were selected on the side of input variables. All variables are presented in Serbian dinars. Descriptive statistics for selected inputs and outputs are presented in Table 1. From the data presented in the following table it can be concluded that all observed variables have increasing trend.

Table 1: Descriptive statistics of inputs and outputs

	Equity	Claims paid	Profit	Total premiums of insurance and reinsurance
Year 2019				
Average	1242979.30	2139045.10	1717849.00	4521906.05
Standard deviation	1295928.62	3197255.56	2602990.32	6719545.98
Year 2018				
Average	1223099.45	2007279.90	1607059.65	4254388.00
Standard deviation	1316049.25	3071770.82	2547984.68	6369318.87
Year 2017				
Average	1198716.86	1681471.62	1440571.90	3841092.29
Standard deviation	1276480.62	2746728.56	2299647.08	5857105.86
Year 2016				
Average	1067782.87	1378967.57	1183896.09	3371402.65
Standard deviation	1218887.41	2294884.58	1933938.94	5327906.06

[1] https://nbs.rs/sr/finansijske-institucije/osiguranje/poslovanje/

Year 2015				
Average	1103543.63	1180080.00	1055327.96	2890566.71
Standard deviation	1187331.93	2033921.15	1884242.06	4843385.64

Source: author's calculations

The second stage of DEA analysis appears to define the drivers of the technical efficiency results. In output-oriented DEA models efficiency scores have values at the interval {0,1}. Thus, the type of the regression for a limited dependent variable is enforced to determine the relationship between the score and relevant factors. Regardless of the frequent criticism of its application (McDonald, 2009), the most commonly used model in this case is the censored regression, known as Tobit regression. The use of standard linear regression may lead to distorted results since the condition of the least-squares is not met (Grmanova & Strunz, 2017). The main assumption of a Tobit model is to censor the dependent variable by determining the threshold of the latent dependent variable. The general formulation of the model is given as follows (Greene, 2003):

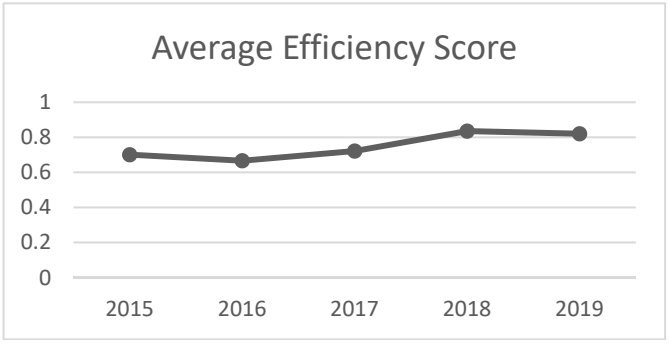
$$y_i^* = x_i'\beta + \varepsilon_i,$$
$$y_i = 0 \text{ if } y_i^* \leq 0 \qquad (2)$$
$$y_i = y_i^* \text{ if } y_i^* \geq 0$$

Where y^*_i is the latent dependent variable of the technical efficiency result, related to the ith country, $x`_i$ is the vector of regressors and ε_i is the error term. The shown formulation is a panel data Tobit model that uses temporal and spatial scale data simultaneously.

4. RESULTS AND DISCUSSION

The results obtained from the output-oriented DEA model with a variable return to scale are shown in Figure 1 and Table 2. Linear programming model (1) is solved for all insurance companies that operate at the Serbian market, separately for every year and obtained average efficiency scores are presented in Figure 1. 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 Serbian insurance companies operate at enviable level of efficiency which is increasing over time. The efficiency is about 70% at the begining of observed time period, while in the recent two years the score is even higher than 80%.

Figure 1: Average Efficiency Score per year



Source: author's calculations

Detailed overview of calculated efficiency scores is presented in Table 2, together with average efficiency scores per years and per companies. It can be noticed that there are slightly changes in the number of insurance companies operating on the Serbian market during observed five years. Some of the companies achieve the maximal efficiency level during whole period such as DDOR Reinsurance, Dunav insurance and Generali insurance, together with Societe Generale, that has very high efficiency scores. Insurance companies with lowest average efficiency scores (under 40%) are Globus insurance, Generali reinsurance and Sava life. The lowest efficiency (67%) in the Serbian insurance market was obtained in 2016, while the highest efficiency of 84% was achieved in 2018.

Table 2: Results of DEA model

DMU	2019	2018	2017	2016	2015	Average per company
AMS	1.00	1.00	0.93	1.00	1.00	0.99
AS nonlife	-	-	-	-	1.00	1.00

AHA nonlife	-	-	-	1.00	0.48	0.74
AHA life	-	-	-	1.00	0.50	0.75
DDOR Novi Sad	0.84	0.81	0.74	0.72	0.58	0.73
DDOR Reinsurance	1.00	1.00	1.00	1.00	1.00	1.00
Dunav insurance	1.00	1.00	1.00	1.00	1.00	1.00
Dunav reinsurance	0.61	0.56	0.39	0.31	1.00	0.58
Energoprojekt garant	-	-	1.00	0.18	0.44	0.54
Generali insurance	1.00	1.00	1.00	1.00	1.00	1.00
Generali reinsurance	0.50	0.40	0.19	0.14	0.31	0.31
Globus insurance	0.29	0.51	0.14	0.17	0.22	0.27
Grawe insurance	0.97	1.00	0.69	0.78	0.91	0.87
Merkur insurance	0.71	0.84	0.51	0.71	1.00	0.76
Milenijum	0.93	1.00	0.87	0.94	1.00	0.95
OTP insurance	1.00	-	-	-	-	1.00
Sava nonlife	0.80	0.81	1.00	0.64	0.58	0.77
Sava life	0.65	0.60	0.23	0.17	0.28	0.39
Societe Generale	-	1.00	1.00	1.00	0.89	0.97
Sogaz	0.92	0.48	0.53	0.19	0.48	0.52
Triglav	0.93	1.00	0.81	0.77	0.68	0.84
Unica nonlife	0.97	1.00	0.76	0.88	0.85	0.89
Unica life	0.81	0.81	0.61	0.66	0.83	0.74
Weiner reinsurance	0.64	1.00	1.00	0.31	0.47	0.68
Weiner Stedise	0.85	0.88	0.77	0.77	0.67	0.79
Average per year	0.82	0.84	0.72	0.67	0.72	

Source: author's calculations

All companies 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 decision makers on possible ways of efficiency improvement for inefficient insurance companies. Those information are presented in the following tables 3, 4, 5 and 6. These tables include results of the applied DEA model (1) for the last year in the data set (2019). Table 3 shows the peer groups for inefficient companies and the corresponding values of lambda. Peer groups are the set of efficient DMUs from which an inefficient unit's inefficiency has been determined. For example, Globus insurance which obtained the lowest efficiency score of 29% in the 2019 should look up to OTP insurance and Dunav insurance in order to improve its allocation of inputs and outputs. Furthermore, all other inefficient countries should follow the experiences of efficient ones in order achieve higher efficiency.

Table 3: Peer groups and lambda values for inefficient companies

DMU	Benchmark(Lambda)
AMS	AMS(1.000000)
DDOR Novi Sad	AMS(0.005990); Dunav insurance(0.292718); Generali insurance(0.333194); OTP insurance(0.368098)
DDOR reinsurance	DDOR reinsurance(1.000000)

Dunav insurance	Dunav insurance(1.000000)
Dunav insurance reinsurance	Dunav insurance(0.039377); OTP insurance(0.960623)
Generali insurance	Generali insurance(1.000000)
Generali reinsurance	DDOR reinsurance(0.453148); OTP insurance(0.546852)
Globus insurance	Dunav insurance(0.006785); OTP insurance(0.993215)
Grawe insurance	Dunav insurance(0.135133); OTP insurance(0.864867)
Merkur insurance	Dunav insurance(0.003454); Generali insurance(0.015547); OTP insurance(0.980999)
Milenijum	AMS(0.668054); Dunav insurance(0.041761); OTP insurance(0.290185)
OTP insurance	OTP insurance(1.000000)
Sava nonlife	AMS(0.469236); Dunav insurance(0.029950); OTP insurance(0.500815)
Sava life	DDOR reinsurance(0.206971); OTP insurance(0.793029)
Sogaz	DDOR reinsurance(0.539469); OTP insurance(0.460531)
Triglav	AMS(0.932384); Dunav insurance(0.067616)
Unica nonlife	AMS(0.809243); OTP insurance(0.190757)
Unica life	Dunav insurance(0.068548); OTP insurance(0.931452)
Weiner reinsurance	AMS(0.097504); OTP insurance(0.902496)
Weiner Stedise	Dunav insurance(0.403773); Generali insurance(0.014932); OTP insurance(0.581295)

Source: author's calculations

Proportionate movements of input and output variables are presented in Table 4. Since 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.

Table 4: Proportionate Movement of input and output variables

DMU	Proportionate Movement (Equity)	Proportionate Movement (Claims paid)	Proportionate Movement (Profit)	Proportionate Movement (Premiums)
AMS	0.00	0.00	0.00	0.00
DDOR Novi Sad	0.00	0.00	883658.13	2275891.76
DDOR reinsurance	0.00	0.00	0.00	0.00
Dunav insurance	0.00	0.00	0.00	0.00
Dunav insurance reinsurance	0.00	0.00	240435.23	633000.25
Generali insurance	0.00	0.00	0.00	0.00

Generali reinsurance	0.00	0.00	101375.87	149907.96
Globus insurance	0.00	0.00	200499.39	583195.92
Grawe insurance	0.00	0.00	10785.75	100503.34
Merkur insurance	0.00	0.00	44337.07	302901.43
Milenijum	0.00	0.00	122347.22	252187.66
OTP insurance	0.00	0.00	0.00	0.00
Sava nonlife	0.00	0.00	272933.95	557369.49
Sava life	0.00	0.00	7506.05	183125.65
Sogaz	0.00	0.00	13303.48	16609.94
Triglav	0.00	0.00	179302.81	370282.61
Unica nonlife	0.00	0.00	44735.70	81348.30
Unica life	0.00	0.00	90421.71	434353.86
Weiner reinsurance	0.00	0.00	182238.43	321601.61
Weiner Stedise	0.00	0.00	423724.42	1645398.41

Source: author's calculations

Usually, besides abovementioned proportionate movements, it is neccessary to take into account the values of slack variables, which are presented in Table 5. (Coelli & Perelman, 1999) stated that is important to report that 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 very important to interpreted and presented slack values together with the efficiency values. Actually, slacks are only the leftover portions of inefficiencies, after proportional reductions in inputs or outputs.

Companies with a high solvency and safety level on average recieve greater efficiency scores (Huang & Eling 2013). Conclusively, higher level of return on equity and assets, higher total investment and lower loss and expanse ratio improve relative efficiency of insurance companies in Serbia.

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