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DEA WINDOW ANALYSIS OF INSURANCE SECTOR EFFICIENCY IN THE REPUBLIC OF SERBIA

Zlata Đurić

University of Kragujevac, Faculty of Economics, Republic of Serbia

✉ *zdjuric@kg.ac.rs*

Milena Jakšić

University of Kragujevac, Faculty of Economics, Republic of Serbia

✉ *milenaj@kg.ac.rs*

Ana Krstić

University of Kragujevac, Faculty of Economics, Republic of Serbia

✉ *anakrstic@kg.ac.rs*

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Abstract: Insurance market is characterized by growing competition. This has imposed needs relating to the continuous capacity building of insurance companies, the continuous improvement of operating results and the assessment of the effects of insurers' financial investment. The ultimate goal of these activities is to implement the planned goals and achieve positive business results. It is evident that the financial stability and efficiency of the insurance sector strengthens the confidence of citizens in this type of financial intermediaries. Bearing in mind the importance of the insurance sector for the financial system and economic system growth and development, the research subject is the analysis of the insurance sector efficiency in the Republic of Serbia. The main research objective is to look at the insurance sector efficiency through the performance analysis of nine selected insurance companies in the period 2007-2018, using DEA window analysis. The analysis and systematization of theoretical research findings, along with empirical data interpretation, description and comparison yielded results pointing to 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.

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1. Introduction

The contemporary environment is characterized by a high degree of risk and uncertainty. In conditions of increasing number of catastrophes, where risks are modified and new ones appear, as well as in conditions of numerous business fluctuations, insurance companies'importance grows along with the increasing complexity of their operations. In addition to the hedging role, insurance companies also perform other important activities, such as giving lending incentives, commodity exchange and more efficient allocation of financial resources. The primary goal of insurance companies, as institutional investors, is to ensure additional liquidity on the financial market, maximize returns with an acceptable level of risk, and invest free capital in order to stimulate economic growth and development. Since the achievement of business and financial goals is the ultimate meaning of insurers' processes and activities on the financial market, then every business segment must be subordinated to the realization of the stated goals.

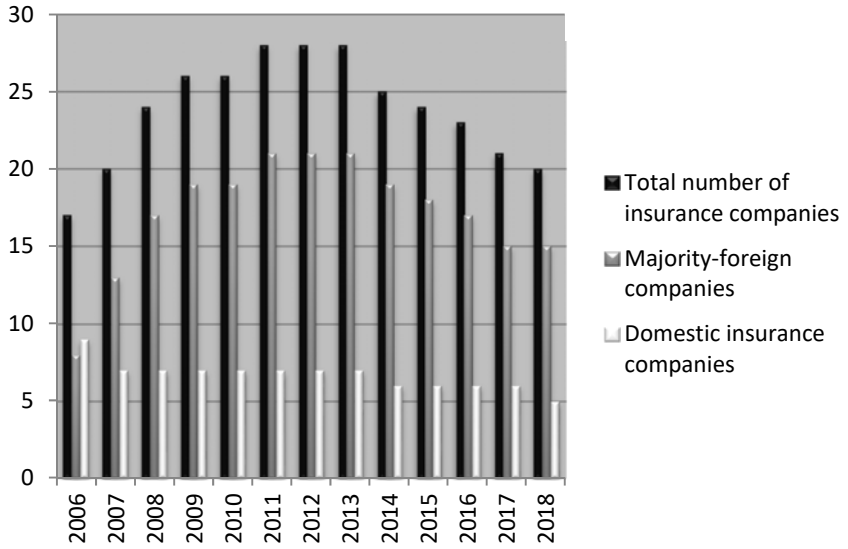
The development of the insurance sector is conditioned by the national economic growth. On the other hand, the insurance sector encourages economic growth. Therefore, every state should strive to improve insurance companies' efficiency within the observed insurance sector. In market-oriented financial systems, economic growth, growth determinants and growth rate boundaries are heavily influenced by financial transactions coming from the insurance sector. Although the Serbian financial system is bank-centric, insurance companies play an important role there.

Numerous studies prove the intuitive perception of the importance and impact of the insurance sector on economic growth (Sibindi, 2014; Lee, 2016; Insurance Europe, 2014). Some authors confirm this link on developing markets as well (Outreville, 2013; Jeremić, 2011). These facts also imply the multidimensional responsibility of the insurance companies themselves, which, by efficiently absorbing the risks of their policyholders, must contribute to their own and the national economy's growth. This problem is pronounced in underdeveloped countries, where social insecurity is a major obstacle for a large part of the population to protect against increasing risks. Unfortunately, the Serbian insurance sector belongs to this group, with a constant but slow growth of insurance activities.

The presence of numerous and strong foreign insurance companies makes the market struggle for new customers very competitive, and often unfair. For this reason, the efficiency of insurers' business activities, with adequate qualitative and quantitative resources, implies their better position and penetration. This fact tackles a growing number of domestic insurance companies in particular. Therefore, measuring the business efficiency of both domestic and foreign insurance companies in the Republic of Serbia (RS) is there to detect key development constraints and point toprospective business policy changes, to reduce the number of insurers leaving the Serbian market. Figure 1 shows that the number of insurance companies in Serbia is constantly decreasing, which increases

monitoring but also the efforts to stop this trend, with special emphasis on the prospects of survival and development of domestic insurance companies.

Figure 1. Total number and ownership structure of insurance companies in the Republic of Serbia



Source: Insurance Supervision Reports of the National Bank of Serbia

This paper examines the efficiency of nine largest insurance companies in the RS by market share in the period from 2007 to 2018, making the time interval much longer than the previous studies, in order to identify the companies with the most stable and efficient operations, as well as benchmarks, i.e. companies with best business practices, which can give guidance for the survival and further progress of other insurance companies in the Republic of Serbia.

The paper proves the following hypothesis:

Reducing administrative and acquisition costs would contribute to business efficiency of insurance companies in the Republic of Serbia.

The paper is organized as follows: first, paper offers a brief literature overview that references the research subject, with special focus on the insurance sector of the Republic of Serbia. What follows is description of the methodology applied, and then the corresponding DEA Window model structuring, chosen to compare and evaluate the efficiency of insurance companies observed over different time periods.

2. Literature overview

Business efficiency is the primary goal and indicator of the prospects for survival, growth and development of each organization. As insurance is a vital input of the national economy, it is necessary to monitor and observe the good and bad sides and insurance companies' performance. Therefore, it is not surprising that a large number of researchers focus on measuring the business efficiency of these market players. The advent and intensive development of modern methodologies for measuring efficiency abandoned the traditional and previously used financial ratios because of their focus on book rather than market values.

One of the commonly used non-parametric methodologies for company efficiency assessment, also used to measure the performance of insurance companies, is Data Envelopment Anaysis (DEA). It rests on Farrell's (1957) idea that the most effective efficiency assessment is achieved by comparing individual firms with the most efficient firms in the observed industrial segments. On this basis, numerous authors have often applied the DEA method to evaluate the performance of insurance companies. Eling & Luhnen (2010) give a good review of the cases of DEA method application to evaluate the insurance companies' efficiency. The same is true with Cummins and Weiss (2011), whose work entitled *Analyzing Firm Performance in the Insurance Industry Using Frontier Efficiency and Productivity Methods* provides an overview of 87 studies devoted to various aspects of insurers' operations. Conceptually, the authors use data envelopment analysis to test and examine economic hypotheses about the dependence of efficient operations on organizational forms, corporate governance, distribution channels, regulatory changes, market structure, mergers and acquisition, as well as to compare the efficiency of insurance companies in different countries and the general level of business efficiency over a period of time. Research has covered both life and non-life and composite insurance companies in a wide geographical area, from America, through Spain, China, Taiwan, Germany, Greece, Italy, Japan, Norway, England, Finland, France, Malaysia, Portugal, Turkey and Austria. Thus, Yang (2006) assesses Canada's life and health insurance performance, using the DEA method. The results show that in the observed period, as of 1998, the entire sector operated at the efficiency boundary. More recently, Wanke & Barros (2016) investigated the role of heterogeneity in the Brazilian insurance sector, using the DEA method, to conclude that Brazilian insurance companies should modify benchmarking procedures to evaluate business efficiency and, thus, raise the level of service quality. Then, Grmanova & Strunz (2017) combine DEA and TOBIT methods to analyze the relationship between technical efficiency and profitability following the example of 15 Slovak insurance companies in the period 2013-2015. They prove no correlation between the technical efficiency using the DEA model and profitability, and find that insurance companies with ROA $\geq$ 2% have higher average technical efficiency than those with ROA $\leq$ 1%, 2%. Shieh et al. (2020) use a four-stage DEA procedure to evaluate the performance of life insurance

companies in China and Taiwan. The results indicate a significant impact of business environment factors on insurance companies' efficiency, as well as the greater efficiency of companies in Taiwan than in China, etc.

Four studies test insurance companies' efficiency in Serbia, three of which using the DEA method. Stepić & Stošić (2012) observe the performance of 19 insurance companies in 2009 and 2010 and test their operational and financial efficiency. They test operational efficiency by comparing insurance costs, capital reserves and the number of employees with total income, while, to test financial efficiency, the authors compare insurance costs, capital reserves and operating expenses with total and other revenues. The results show that the following 10 insurance companies have the most efficient operations: Dunav osiguranje, GRAWE, Merkur, AMS, Delta Generali, DDOR Novi Sad, Triglav, Takovo and Wiener Stadtische, while 9 insurance companies record inefficient operations: Energoprojekt Garant, Sava, Uniqa, Milenijum, AS, AXA and Grawe.

Knežević et al. (2015) investigate the relative and scale efficiency of 27 insurance companies in the period 2009-2011. Comparing assets, labor and equity with total income and pre-tax income, they find that AMS, Delta Generali and Sava have the best relative efficiency, while Delta Generali and Sava have the best scale efficiency.

Lukić et al. (2018) test the business efficiency of 16 insurance companies in 2016. They compare total assets, number of employees and capital with operating income and net profit, and identify Generali, Grawe, Milenijum, Societe Generale and Energoprojekt Garant as the most efficient insurers. Mandić et al, (2017) apply AHP and TOPSIS methods, and find that Dunav osiguranje, DDOR Novi Sad, Delta Generali, Wiener Stadtische and Grawe osiguranje operate efficiently.

3. Methodology

Data Envelopment Analysis (DEA) is a mathematical, non-parametric approach for calculating efficiency that does not require a specific functional form. It is used to evaluate the decision-making unit (DMU) performance by reducing multiple input variables to one "virtual" input and reducing multiple output variables to one "virtual" output, using weight coefficients.

The DEA model ratio, also known as the Constant Returns to Scale (CRS) model (Charnes et al., 1978) measures the efficiency of the *j*-th DMU as the maximum quotient of the weighted outputs and weighted inputs, i.e.:

$$(\max)h_k = \frac{\sum_{r=1}^{s} u_r y_{rk}}{\sum_{i=1}^{m} v_i x_{ik}} \tag{1}$$

$$,\frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1, \text{j=1,2,..,} n$$

$$u_r \geq 0, \text{r=1,2,..,}s$$

$$v_i \geq 0, \text{i=1,2,..,}m$$

where:

h_k–relative efficiency of *k*-th DMU;

n –number of DMUs to be compared;

m –number of input variables;

s –number of output variables;

u_r–weight coefficient for output r;

v_i–weight coefficient for input i.

The CCR ratio model calculates the total technical (radial) efficiency that includes both pure technical efficiency and scale efficiency. The value of the objective function h_k ranges between 0 and 1. If the value of h_k is 1, the k-th DMU is relatively efficient, and if less than 1, the DMU_k is relatively inefficient and the h_k value indicates the required percentage reduction of the input to become efficient (Cooper et al., 2007)

The mathematical problem in (1) has its equivalent dual form, more practical to solve:

$$min_{\theta,\lambda}\ \theta$$

$$\text{s.t.} \begin{cases} -y_i + Y\lambda \geq 0 \\ \theta x_i - X\lambda \geq 0 \\ \lambda \geq 0 \end{cases}$$

where $\theta$is the scalar, and$\lambda$the non-negative $K\times1$ variable vector expressing the influence of the reference DMUs on the efficiency of the observed DMUs. The obtained$\theta$is the technical efficiency of the k-th DMU, which satisfies the condition $\theta \leq 1$. If $\theta = 1$, DMU is on the boundary of best practice frontier and technically efficient. The CCR model assumptions areappropriate when all DMUs operate at optimal economies of scale. Where this is not the case, Banker et al. (1984) propose a VRS (Variable Returns to Scale) DEA model:

$$min_{\theta,\lambda}\ \theta$$

$$\text{s.t.} \begin{cases} -y_i + Y\lambda \geq 0 \\ \theta x_i - X\lambda \geq 0 \\ N'\lambda = 1 \\ \lambda \geq 0 \end{cases}$$

where N is the unit K× 1vector. The technical efficiency, calculated by applying the CCR model, is commonly referred to as technical efficiency, while that derived from the VRS model is known as pure technical efficiency. The VRS model provides a measure of efficiency that ignores the impact of business scale by comparing the DMU only with other units of similar scale. Pure technical efficiency is always greater than or equal to technical efficiency. The ratio of technical and pure technical efficiency is known as scale efficiency (SE):

$$SE = \frac{\theta^*_{CCR}}{\theta^*_{VRS}}$$

where $SE \leq 1$.

Scale efficiency is used to determine the distance from the most productive value of the observed DMU and indicates whether the observed unit operates with the optimum activity scale.

For a VRS-efficient DMU, which is CCR-inefficient, the scale efficiency is equal to 1. If the scale efficiency of a DMU_k is equal to 1, it operates at the optimum activity scale. So technical efficiency can be separated into two components: scale efficiency and pure technical efficiency, which can be done by comparatively applying both CCR and VRS models on the same data of the observed DMU. This decomposition shows the sources of inefficiency, i.e. whether it is caused by operational inefficiency (pure technical efficiency), adverse conditions (scale efficiency), or both (technical efficiency).[1]

4. Model structuring

In order to analyze the performance of the observed decision-making units over a period of time, it is possible to use the extension of the DEA method. Scientific and professional studies refer to this extension as the DEA Window Analysis, and is a variant of the traditional DEA approach that can be described as a moving average technique that measures efficiency by considering decision-making units in different time periods as a separate decision unit whose performance is measured and compared with the performance of all other single-window decision-making units (Wang et al., 2013; Yang and Chang, 2009; Cooper et al., 2011). According

[1] For more details about DEA method see: Dyson et al. 2001; Sarkis, 2002, 2007; Sherman & Zhu, 2006; Cooper et al, 2007; Cook et al, 2005, 2014; etc

to Kutlar et al. (2015), the smaller window length in this analysis may lead to fewer DMUs, which, in combination with a large number of variables, reduces the discriminating power of the analysis. On the other hand, the larger the window length, the more likely it is that the results are wrong, because due to the window being too long, important changes that occur at a certain point in time can be neglected. In this extension of the traditional DEA model, the focus is on *n* DMU (j = 1,.., n) at time intervals (t = 1,..., P), and all use n inputs to obtain m outputs. The observed set consists of *n x P* entities and one entity in period *t*. A window starting at 1, 1 ≤ l ≤ P, of length *w*, 1 ≤ *w* ≤ *P*-1, is denoted by *lw*, and consists of *n* × *w* observations (Jia and Yuan, 2017). For *n (n = 1,..., N)* decision units, observed in period *T (T = 1,.., T)*, *n* input and *m* output variables, output-oriented CCR DEA Window model of the observed DMU_k in period t is (Asmild et al., 2004; Gu and Yue, 2011):

$$\theta_k = max_{\theta,\lambda}(\theta) \tag{2}$$

s.t.
$$x_{kw} \times \lambda \leq 0$$
$$-\theta^t_{ktw} \times y^t_{ktw} + y_{kw} \times \lambda \geq 0 \;\; t = 1,..,T$$
$$\lambda_n \geq 0 \;\; (n = 1, \ldots., N \times w)$$

where:
$$1 \leq k \leq T \;\; i \; 1 \leq \; w \leq t - k,$$

and λ_n is a dual variable, i.e. a dual weight that shows the significance assigned to DMU_n (n = 1,2,.., *Nxw*) when defining the input-output mix of a hypothetical composite unit with which the DMU_k will be directly compared.

To evaluate and analyze the technical effectiveness of the insurance companies observed in the period 2007-2018, a DEA Window analysis is applied and two relevant models formed, which rest on the following assumptions:

- The nine insurance companies with the largest share on the Serbian insurance market are observed: AMS, DDOR (a), Dunav osiguranje (b), Generali (c), UNIQA (d), GRAWE (e), Milenijum (g), Triglav (h), WIENER (k);
- The observed time period is 2007 - 2018;
- The input variables are: I1 - insurance number; I2 - administration costs; I3 - acquisition costs
- The output variables are: O1 - investment income; O2 - claims settled
- The selected models are output-oriented CRS and VRS DEA Window.

The selection of insurance companies was made on the basis of their share on the national insurance market, as well as the relevant data available for the purposes of the analysis performed in the observed time interval. Previous studies on insurance companies' efficiency have shown different approaches to selecting relevant performance indicators, mainly due to no data on individual input-output variables. Generally, researchers typically choose labor costs, costs of business

services and materials, and capital as input variables. In this paper, according to publicly available reports on insurance companies' operations, relevant input indicators are administration costs and acquisition costs, asoperating costs, and the number of insurance contracts concluded as a counterpart to costs of business services and materials. The choice of output variables is determined according to the conceptual insurance basis, which focuses on the payment of losses incurred due to realization of insured risks. Therefore, most researchers use the data on claims paid as well as on the results of investment as output variables.

Data for selected input and output indicators of the DEA model is collected from the balance sheets and profit and loss statements of insurance companies, available on the National Bank of Serbia's website.[2]

Table 1. Descriptive statistics

Variable	Insurance number	Administration costs	Acquisition costs	Investment income	Claims settled
max	6734549,00(DDOR-2018)	2655861,00	6781891,00	3435571,00 (GENERALI – 2018)	10689378,00 (DUNAV – 2018)
min	83386,00	0,00 (MILENIUM – 2007)	135784,00 (UNIQUA – 2007)	5153,00	72370,00
mean	541950,76	709258,26	1779110,42	691571,40	2728495,18
SD	738242,32	644934,8052	1589825,34	704612,06	2651291,05

*Source:*Authors

Descriptive analysis of input and output variables shows that the best performance in terms of input variables was in 2007 (MILENIJUM and UNIQA) and 2018 (DDOR), while in terms of achieved results, 2018 was clearly the most successful year (GENERALI and Dunav, Table 1).

5. Dea window model results to assess insurance sector efficiency in RS (2007-2018)

5.1. Results of the CRS DEA Window Analysis and Discussion

Using the DEA Window analysis, with nine windows, each of $w = 4$[3]length (width), the average relative technical efficiency of selected insurance companies

[2] https://nbs.rs/sr_RS/finansijske-institucije/osiguranje/

[3]Charnes et al., 1994propose the window length of three or four time units, believing that such window length provides and optimal balance between the need for information and stability of efrficiency measure.

over the observed period, 2007-2018, is calculated, through *n* x *p* x *w*observations[4], where:

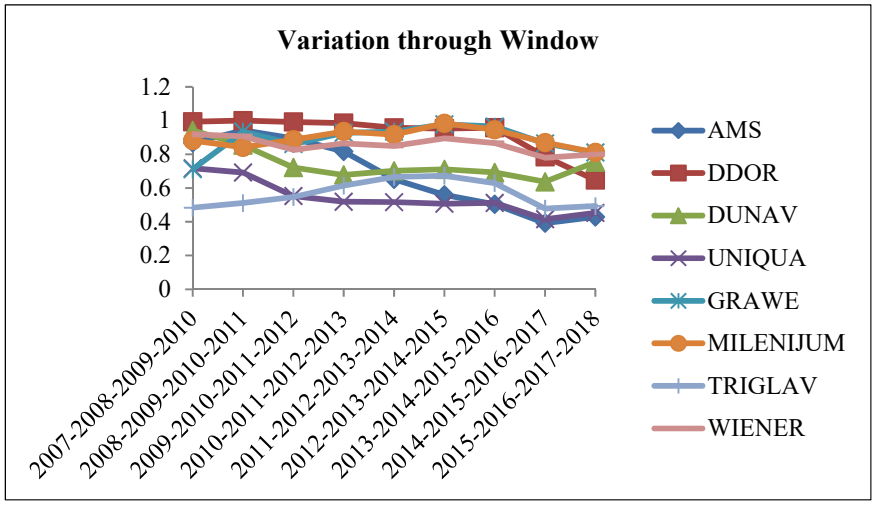
n = 8,number of DMU,

p= 4, window length,

w= 9,number of windows,

so the total number of observations, i.e. of different DMUs is equal to 288[5].

Figure 2. Comparative view of average efficiency trend by window (CRS DEA Window model) UNIQA



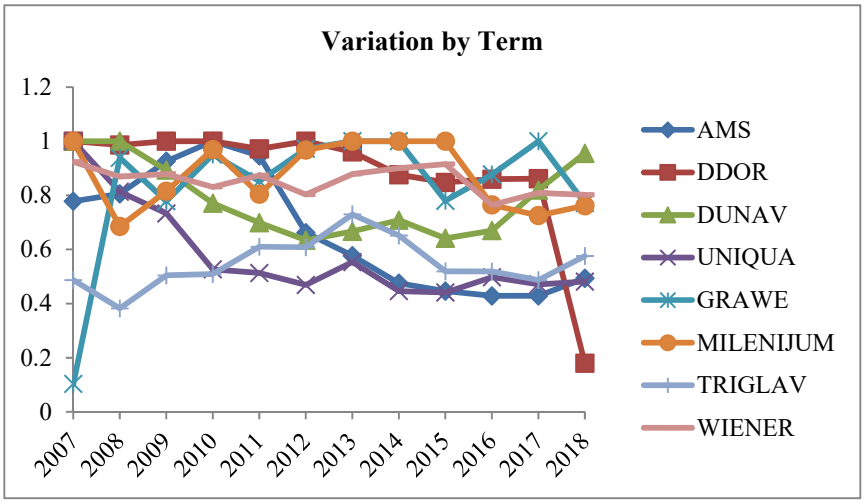
*Source:*Authors

The analysis of the results obtained using the DEA Window CCR model shows a continuous declining trend of average efficiency of insurance companies, observed through windows (Figure 2).

The lowest average window efficiency was recorded in 2015-2018 and was below 80% of marginal efficiency for most observed insurance companies, except in the case of GRAWE and MILENIJUM insurance companies. The highest average efficiency by windows was in the period 2008-2011, and for most insurance companies amounted to over 90% of marginal efficiency, while DDOR insurance in that period, as well as in the whole observed period, only operated at the efficiency, i.e. best practice boundary.

[4] Cooper et al., (2006)., p.327.
[5]All calculations are made using the DEA Solver – LV8 software package

Figure 3. Comparison of achieved average efficiency by year (CRS DEA Window model)



Source: Authors

Average efficiency per year gives a clearer picture. In this case too, there is a pronounced declining trend of achieved technical efficiency for most insurance companies, especially since 2013. Only MILENIJUM and DDOR insurance companies stand out. In 2007, 2013, 2014 and 2015, MILENIJUM recorded technically efficient use of available resources, but there is also a visible declining efficiency trend to 70% of best practices in 2016, 2017 and 2018 (Table 2, Figure 3). DDOR recorded similar performance in terms of technical efficiency, whose average technical efficiency was 1 in 2007, 2009, 2010 and 2012, or over 85% of efficiency in almost the entire observed period, but also a drastic fall in 2018, when efficiency was only 17% of the marginal fficiency. UNIQA achieved the worst performance in this regard, with a continuous declining trend of technical efficiency throughout the observed period, not exceeding 50% of the reference efficiency since 2011 (Figure 3). Generally speaking, in terms of technical efficiency, the insurance sector had very poor performance in the observed period. Average technical efficiency per year did not exceed 81% of marginal efficiency, while the most inefficient use of resources was achieved in 2018 (62%, Figure 3).

Table 2. Average efficiency by window and year (CRS DEA Window model)

	2007-2008-2009-2010	2008-2009-2010-2011	2009-2010-2011-2012	2010-2011-2012-2013	2011-2012-2013-2014	2012-2013-2014-2015	2013-2014-2015-2016	2014-2015-2016-2017	2015-2016-2017-2018
AMS	0,86	0,94	0,89	0,81	0,65	0,55	0,50	0,39	0,42
DDOR	0,99	1	0,99	0,98	0,95	0,95	0,95	0,78	0,64
DUNAV	0,94	0,85	0,72	0,67	0,70	0,71	0,69	0,63	0,75
UNIQA	0,71	0,69	0,55	0,51	0,51	0,50	0,51	0,41	0,45
GRAWE	0,71	0,93	0,86	0,92	0,93	0,97	0,96	0,86	0,81
MILENIJUM	0,88	0,84	0,88	0,93	0,91	0,98	0,94	0,86	0,81
TRIGLAV	0,48	0,51	0,54	0,61	0,66	0,67	0,62	0,47	0,49
WIENER	0,91	0,90	0,82	0,86	0,84	0,89	0,86	0,77	0,79

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
AMS	0,77	0,80	0,92	1	0,94	0,66	0,57	0,47	0,44	0,42	0,42
DDOR	1	0,98	1	1	0,97	1	0,96	0,87	0,84	0,85	0,86
DUNAV	1	1	0,89	0,77	0,69	0,63	0,66	0,70	0,64	0,66	0,81
UNIQA	1	0,81	0,73	0,52	0,51	0,46	0,55	0,44	0,44	0,49	0,47
GRAWE	0,10	0,93	0,77	0,95	0,85	0,97	1	1	0,77	0,87	1
MILENIJUM	1	0,68	0,81	0,96	0,80	0,96	1	1	1	0,76	0,72
TRIGLAV	0,48	0,38	0,50	0,50	0,60	0,60	0,72	0,65	0,51	0,51	0,48
WIENER	0,92	0,86	0,87	0,83	0,87	0,80	0,87	0,90	0,91	0,76	0,80

Source: Authors

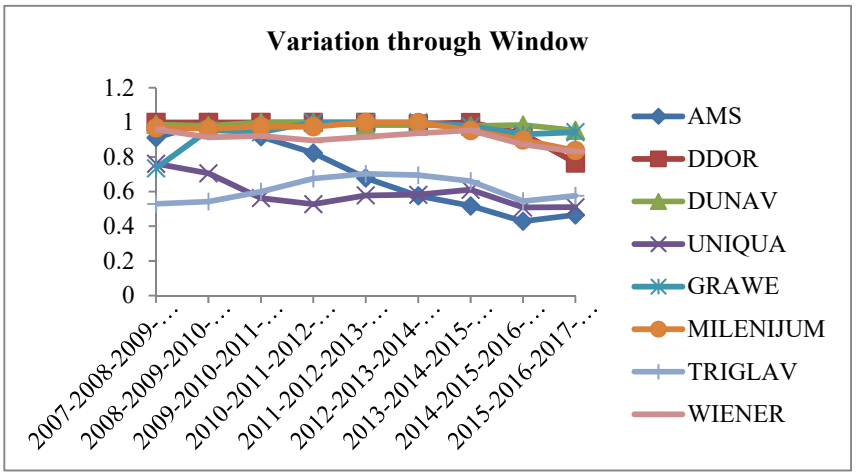
5.2. Results of the VRS DEA Window analysis and discussion

The analysis of the results obtained using the DEA Window VRS model shows a continuous downward trend in the average pure technical efficiency of insurance companies, observed through windows (Table 1 - Appendix, Figure 4).

The lowest average window efficiency was also observed in period 2015-2018 and was below 80% of best practice for most of the insurance companies observed, except in the case of GRAWE and DUNAV. The highest average efficiency by windows was achieved in the periods 2008-2011, 2009-2012 and 2010-2013, when DDOR, DUNAV, GRAWE and MILENIJUM insurance stood out. When

analyzing average pure technical efficiency by years, the fluctuations observed are identical to those of the calculated average CRS efficiencies, and the conclusion is identical: if we eliminate the impact of business scale (VRS model), DUNAV had the best performance in the observed period. For many years, it operated at the boundary of efficiency. AMS recorded the worst performance, whose pure technical efficiency, with the exception of the first few years (2007-2011), was less than 60% of best practice and in some years below 50% (Table1 - Appendix, Figure 5). GRAWE had the lowest pure technical efficiency in the observed period (0.13 in 2007), but after that year showed very good performance in comparison with other insurance companies as well as in the whole observed period. In addition, there was a sharp decline in the pure technical efficiency of DDOR in 2018 (22%), but also a very stable trend in the pure technical efficiency trend of DUNAV.

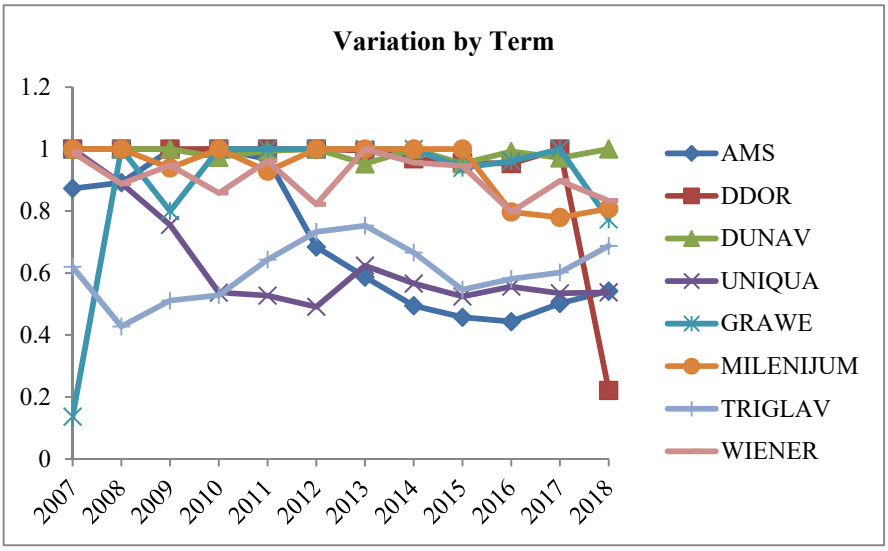
Figure 4. Comparative view of the achieved average efficiency trend by window (VRS DEA Window model)



*Source:*Authors

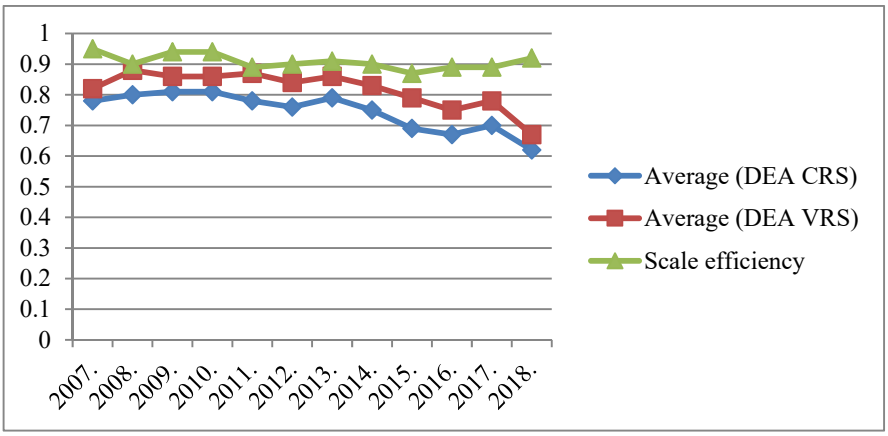
The analysis of scale efficiency also indicates the very poor performance of the insurance sector as a whole, as in all years of the observed period the scale efficiency was below 100%, especially in the period 2015-2018, when it was below 90% (Figure 6).

Figure 5. Comparison of achieved average efficiency by year (VRS DEA Window model)



*Source:*Authors

Figure 6. Comparison of average efficiency trends of the insurance sector in the RS in the period 2007-2018



*Source:*Authors

6. Conclusion

When looking at the insurance sector globally, the analyzed period was marked by an increase in the non-life insurance premium, which grew twice as fast as the life insurance premium. The much lower global growth in life insurance premiums is a consequence of weak industrial development as well as the economic crisis in many European countries. Almost all parts of the world have contributed to the positive growth of insurance premiums, but the differences in the growth of insurance premiums in developed and developing countries are considerable. Developing countries' insurance markets have seen a positive upward trend in total insurance premiums, which has led to an increase in total insurance premiums globally.

The insurance sector in the Republic of Serbia is registering a rising share of foreign-owned insurance companies. During the observed period, there was an increase in total insurance premiums as well as per capita insurance premiums. When it comes to the insurance premium structure, non-life insurance is dominant, with the life insurance premium tending to increase over the analyzed period. The share of non-life insurance in the total premium is three times higher than the life insurance premium, which indicates that the insurance market is underdeveloped. However, it is favorable that the share of life insurance premiums in the total premium is constantly increasing. On the Serbian life insurance market, life insurance products play the leading role, i.e. insurance with a precisely defined payment period, life insurance, death insurance and mixed life insurance. The main cause of underdevelopment of this type of insurance is, first of all, the bank-centric financial market, low living standard and people's low awareness regarding the benefits of this type of insurance.

The analysis of the results obtained using the DEA Window analysis (CRS and VRS models) shows a continuous declining trend of average efficiency of insurance companies, both through windows and by years. The lowest average technical efficiency per window was recorded in the period 2015-2018, while the highest average efficiency per window was achieved in the period 2008-2011, and for most insurance companies was over 90% of the marginal efficiency. Average technical efficiency by year also shows a declining trend for most insurance companies, especially since 2013. Only MILENIJUM and DDOR insurance companies stand out. DDOR achieved similar performance in terms of technical efficiency, whose average technical efficiency was 1 in 2007, 2009, 2010 and 2012, or over 85% of efficiency in almost the entire observed period, but also a drastic decrease, recorded in 2018, when efficiency was only 17% of the marginal efficiency. UNIQA had the worst performance in this respect, with a continuous declining trend of technical efficiency throughout the observed period, not exceeding 50% of the reference efficiency since 2011. Generally speaking, in terms of technical efficiency, the insurance sector had very poor performance in the

observed period. Average technical efficiency per year did not exceed 81% of marginal efficiency, while the most inefficient use of resources was in 2018 (62%). A similar, continuously declining trend is also in the analysis of the average pure technical efficiency of insurance companies. The lowest average window efficiency was also observed in the period 2015-2018 and for most of the insurance companies observed was below 80% of best practice, while the highest average window efficiency was achieved in the periods 2008-2011, 2009-2012 and 2010-2013, when DDOR, DUNAV, GRAWE and MILENIJUM stood out. When analyzing average pure technical efficiency by years, the fluctuations observed are identical to those of the calculated average CRS efficiencies, and the conclusion is identical: if eliminating the impact of business scale (VRS model), DUNAV had the best performance in the observed period. For many years, it operated at the boundary of efficiency, while AMS had the worst performance, whose pure technical efficiency, with the exception of the first few years (2007-2011), was less than 60% of best practice and in some years below 50%. GRAWE had the lowest pure technical efficiency in the observed period (0.13 in 2007), but after that year it had very good performance in comparison with other insurance companies as well as in the whole observed period. In addition, DDOR recorded a sharp decline in the pure technical efficiency in 2018 (22%), and DUNAV also had a very stable trend of pure technical efficiency. The analysis of scale efficiency also indicates the very poor performance of the insurance sector as a whole, as in all years of the observed period the scale efficiency was below 100%, especially in the period 2015-2018, when it was below 90%.

In that sense, it is fundamental to identify sources of inefficiency in order to create the preconditions for a more dynamic, sustainable development of the insurance sector in the Republic of Serbia, which would also increase the confidence of potential users of services and improve their quality.

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DEA WINDOW ANALIZA EFIKASNOSTI SEKTORA OSIGURANjA U REPUBLICI SRBIJI

Rezime: Tržište osiguranja karakteriše rastuća konkurencija. Ova je okolnost nametnula potrebe koje se odnose na stalno jačanje kapaciteta osiguravajućih kompanija, kontinuirano poboljšanje rezultata poslovanja i procenu efekata ulaganja finansijskih sredstava osiguravača. Krajnji cilj navedenih aktivnosti je realizacija planiranih ciljeva i ostvarivanje pozitivnih rezultata poslovanja. Evidentno je da finansijska stabilnost i efikasnost sektora osiguranja jača poverenje građana u ovu vrstu finansijskih posrednika. Imajući u vidu značaj sektora osiguranja za razvoj finansijskog sistema i rast ekonomskog sistema, predmet istraživanja rada je analiza efikasnosti sektora osiguranja u Republici Srbiji. Osnovni cilj istraživanja jeste da se sagleda efikasnost sektora osiguranja kroz analizu performansi devet izabranih osiguravajućih kompanija u periodu 2007-2018. godina, primenom DEA WINDOW analize. Kroz analizu i sistematizaciju saznanja dobijenih teorijskim istraživanjima, kao i interpretaciju, deskripciju i upoređivanje podataka dobijenih empirijskim istraživanjem dobijeni su rezultati koji ukazuju na vrlo loše performanse sektora osiguranja u celini, jer je u svim godinama posmatranog perioda relativna prosečna efikasnost (tehnička, čista tehnička i efikasnost obima) ispod 100%, posebno u periodu 2015-2018 godina.

Ključne reči: osiguranje, performanse, efikasnost**,** DEA WINDOW analiza

Authors' biographies

Zlata Đurić, PhD, is Assistant Professor at the Faculty of Economics, University of Kragujevac, Republic of Serbia. The main areas of her reseach interests are insurance and financial and actuarial mathematics. Zlata Đurić is author or coauthor of a number of scientific papers published in international and national journals, as well as the proceedings of international scientific conferences.

Milena Jakšić, PhD, is employed at the Faculty of Economics, University of Kragujevac. She obtained the title of full professor in 2017 for scientific areas: finance, financial institutions and insurance - the subject Fundamentals of Economics and the subject Financial markets. She was engaged within the series of scientific researchs during bthe period 2011-2015, funded by the Government of the Republic of Serbia and is currently engaged in the project PIBAS, ev.br. III 41010, as a member of the subproject entitled "Management and marketing research to support the implementation of interdisciplinary projects." She is the author and co-author of a number of scientific papers. She has participated in international and domestic conferences and scientific and professional training locally and abroad. Scientific research areas of interest include are the follwing: funding sources economic growth, financial markets and risk management of financial institutions.

Ana Krstić, MSc, is a Teaching and Research Assistant at the Faculty of Economics, University of Kragujevac, Republic of Serbia. She is a PhD student at the Faculty of Economics, University of Belgrade. Her main areas of scientific interest are operational research and optimization methods. Ana Krstić published several scientific papers in international and national journals and participated in many scientific international conferences.

Appendix

Table 1. Pure average efficiency by window and year (VRS DEA Window model)

	2007-2008-2009-2010	2008-2009-2010-2011	2009-2010-2011-2012	2010-2011-2012-2013	2011-2012-2013-2014	2012-2013-2014-2015	2013-2014-2015-2016	2014-2015-2016-2017	2015-2016-2017-2018
AMS	0,91	1	0,91	0,82	0,67	0,57	0,51	0,42	0,46
DDOR	1	1	1	1	0,99	0,99	0,99	0,93	0,76
DUNAV	0,98	0,97	0,99	1	0,98	0,98	0,97	0,98	0,95
UNIQA	0,76	0,70	0,56	0,52	0,57	0,58	0,61	0,50	0,51
GRAWE	0,73	0,95	0,94	0,99	0,99	1	0,97	0,93	0,94
MILENIJUM	0,96	0,96	0,97	0,97	0,99	1	0,95	0,89	0,83
TRIGLAV	0,52	0,54	0,60	0,67	0,70	0,69	0,66	0,54	0,57
WIENER	0,95	0,91	0,92	0,89	0,91	0,93	0,95	0,87	0,83

	2007	2008	2009	2010	2011	2012	2013	2014	2015
AMS	0,87	0,89	0,99	1	0,96	0,68	0,58	0,49	0,45
DDOR	1	1	1	1	1	1	0,99	0,96	0,95
DUNAV	1	1	1	0,97	0,99	1	0,95	1	0,95
UNIQA	1	0,88	0,75	0,53	0,52	0,49	0,62	0,56	0,52
GRAWE	0,13	1	0,79	0,99	0,99	1	1	1	0,93
MILENIJUM	1	0,99	0,93	1	0,92	1	1	1	1
TRIGLAV	0,61	0,42	0,51	0,52	0,64	0,73	0,75	0,66	0,54
WIENER	0,98	0,88	0,94	0,85	0,96	0,82	1	0,95	0,94