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ANALYSIS OF THE EFFICIENCY OF INSURANCE COMPANIES BY LINES OF INSURANCE IN SERBIA USING THE COCOSO METHOD

SCIENTIFIC PAPER

Abstract

Lately, as known, the efficiency (performance) of insurance companies has been increasingly assessed through the multiple criteria analysis. Having this in mind, this paper analyses the efficiency of insurance companies by lines of insurance in Serbia using the COCOSO method (*Combined Compromise Solution*). We have proposed adequate measures, within this context, to upgrade the future efficiency of insurance companies in Serbia. The results of efficiency survey of insurance companies by lines of business in Serbia using the COCOSO method has revealed that the method is best applied in property insurance, followed by the accident insurance and voluntary health insurance, motor vehicle insurance, non-life insurance not classified in subgroups, life insurance other than pure life, liability insurance, pure life insurance, insurance of vessels and transport, credit and guarantee insurance and aircrafts insurance. Such efficiency ranking of the insurance companies by insurance lines was impacted by numerous macro and micro factors (living standard, economic climate, political situation and the like).

***Key words**: efficiency, lines of business, Serbia, determinants, COCOSO method.*
***Jel classification**: C2, C6, G1, G2, G22*

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I. Introduction

The assessment of the efficiency of insurance companies based on multiple criteria analyses (Isseveroglu, 2015; Mandic, 2015; Tsvetkova, 2021) is a very current, complex and significant topic. Bearing this in mind, we made the subject of research in this paper to comprise the efficiency analysis of insurance companies by lines of business in Serbia using the COCOSO method. Our aim and objective was to treat this matter as complexly as possible and propose adequate measures to improve the efficiency of insurance companies in Serbia in the future which among other things, reflects the scientific and professional contribution of this paper.

The abundant literature has recently been dedicated to analysing the efficiency of companies in different economic sectors based on the COCOSO method. However, there are few papers of this kind in the financial services sector (Ersoy, 2017; Lukić, 2019, 2020; Gaur, 2020), i.e. in the insurance sector, especially in Serbia (Kočović, 2010; Lukić, 2016; Rakonjac-Antić, 2018). In other words, as far as we are aware, the literature in Serbia offers no complete paper dedicated to analysing the efficiency of insurance companies by insurance lines in the Serbian market on the basis of COCOSO method.

The baseline research hypothesis of this paper is that continuous monitoring of the efficiency of insurance companies by insurance lines is a presumption for the future improvement thereof - in our case, in Serbia. In addition to the COCOSO method, we also used the statistical analysis to some extent and/or the ratio analysis so as to treat the observed matter as complexly as possible.

The necessary empirical data was collected from the Serbian Business Registers Agency. The data was developed in accordance with relevant international standards. There are no restrictions to any international comparison in this field.

II. COCOSO Method

COCOSO (*Combined Compromise Solution*) method is based on the integration of simple weight additives and models of exponentially weight products. It provides a brief overview of compromise solutions and is broadly applied. To solve the COCOSO decision-making problem, after defining alternatives and related criteria, the following steps are implemented (Yazdani, 2019):

(1) Determining the initial decision matrix X, for *m* alternatives, and *n* criteria as shown below:

$$x_{ij} = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix}; i = 1,2,\dots,m; j = 1,2,\dots,n. \quad (1)$$

(2) Normalization of elements of the initial decision-making matrix, using the following equations (Zeleny, 1973):

$$r_{ij} = \frac{x_{ij} - \min\limits_i x_{ij}}{\max\limits_i x_{ij} - \min\limits_i x_{ij}} \text{ ; for the benefit criterion,} \quad (2)$$

$$r_{ij} = \frac{\max\limits_i x_{ij} - x_{ij}}{\max\limits_i x_{ij} - \min\limits_i x_{ij}} \text{ ; for the cost criterion,} \quad (3)$$

(3) By applying the equations (4) and (5) we reach the sum of weight comparable sequences (series) S_i and the power of weight comparable sequences P_i for each alternative, respectively:

$$S_i = \sum_{j=1}^{n} (w_j r_{ij}), \quad (4)$$

Where: S_i is the value obtained based on grey relational generation approach:

$$P_i = \sum_{j=1}^{n} (r_{ij})^{w_j}, \quad (5)$$

Where: P_i is the value also obtained as per WASPAS *(Weighted Aggregated Sum Product Assessment)* multiplicative item; w_j marks the weight of the *j* criterion, and $\sum_{j=1}^{n} w_j$.

(4) Calculation of relative weights alternative to aggregation of strategies based on the idea of MULTIMOORA *(Multi-Objective Optimization on the basis of a Ratio Analysis plus the full MULTIplicative form)* method (Brauers & Zavadskas, 2006), using the equations (6) – (8):

$$k_{ia} = \frac{P_i + S_i}{\sum_{i=1}^{m}(P_i + S_i)}, \quad (6)$$

$$k_{ib} = \frac{S_i}{\min\limits_i S_i} + \frac{P_i}{\min\limits_i P_i}, \quad (7)$$

$$k_{ic} = \frac{\lambda(S_i) + (1-\lambda)(P_i)}{\left(\lambda \max_i S_i + (1-\lambda) \max_i P_i\right)}, \quad (8)$$

The equation (6) expresses the arithmetic mean of the WSM sums *(weighted product method)* and WPM *(weighted sum method)* result *(scores)*.

The equation (7) expresses the relative result WSM and WPM compared with the worst case.

The equation (8) calculates the balanced result of the WSM and WPM model.

In the equation (8) the value λ (usually λ=0.5) defines the decision-maker and 0≤λ≤1.

(6) Ranging alternatives on the basis of k_i value (the more important, the better):

$$k_i = (k_{ia}k_{ib}k_{ic})^{\frac{1}{3}} + \frac{1}{3}(k_{ia}k_{ib}k_{ic}). \quad (9)$$

III. Efficiency Measurement of Insurance Companies by Lines of Insurance in Serbia Based on the COCOSO Method

When measuring the efficiency of insurance companies by insurance lines in Serbia, applying the COCOSO method, we took the following criteria: C1 – number of companies, C2 – operating (functional) expenditures, C3 – costs of providing the insurance services C4 – operating (functional) income, C5 – profit from investment activities and C6 – operating profit. The observed lines of insurance represent the alternatives: A1 – pure life insurance, A2 – life insurance other than pure life, A3 – accident insurance and voluntary health insurance, A4 – motor vehicle insurance, A5 – insurance of vessels and transportation, A6 – aircrafts insurance A7 – property insurance A8 – liability insurance A9 – credit and guarantee insurance, and A10 – non-life insurance not classified in subgroups. Calculating the efficiency of insurance companies by insurance lines in Serbia was done using the COCOSO Software-Excel. The results obtained are shown both in the tables below and graphically.

The Table 1 presents the initial data for the efficiency measurement of the insurance companies by lines of insurance in Serbia in 2019.

Table 1 Initial Data for Efficiency Measurement of Insurance Companies by Lines of Insurance in Serbia in 2019

	Number of companies	Operating (functional) expenditures	Costs of providing the insurance services	Operating (functional) income	Profit from investment activities	Operating profit
Pure life insurance	10	19432	5696	22166	4689	2734
Life insurance other than pure life	10	1180	688	2255	308	1074
Accident insurance and voluntary health insurance	11	4010	2800	5848	574	1837
Motor vehicle insurance	11	6201	3059	8089	381	1916
Insurance of vessels and transportation	9	269	356	656	126	389
Aircrafts insurance	6	21	131	25	56	13
Property insurance	11	7814	4527	11894	848	3980
Liability insurance	10	15198	8786	33407	1339	18208
Credit and guarantee insurance	8	329	591	1084	206	754
Non-life insurance not classified in subgroups	11	1138	2095	2825	207	1686
Total	19	56608	29273	89965	8890	33567

Note: Data are shown in RSD million. The number of companies is shown as a full number.
Source: Agency for Business Register of the Republic of Serbia

Table 2 shows statistics of initial data used to analyse the efficiency of insurance companies by insurance lines in Serbia.

Table 2 Statistics

Statistics							
		1. Number of companies	2. Operating (functional) expenditures	3. Costs of providing the insurance services	4. Operating (functional) income	5. Profit from investment activities	6. Operating profit
N	Valid	10	10	10	10	10	10
	Missing	0	0	0	0	0	0
Median		10.0000	2595.0000	2447.5000	4336.5000	344.5000	1761.5000
Std. Deviation		1.63639	6814.97017	2791.84178	10976.44211	1396.19596	5378.87633
Minimum		6.00	21.00	131.00	25.00	56.00	13.00

Maximum	11.00	19432.00	8786.00	33407.00	4689.00	18208.00
Test Statistics[a]						
N	10					
Chi-Square	38.514					
df	5					
Asymp. Sig.	.000					
a. Friedman Test						

Note: The above calculations were made using the SPSS software program.

The operating profit is above average for life insurance, accident insurance and voluntary health insurance, motor vehicle insurance, property insurance and liability insurance. This profit is below average with other lines of insurance. The *Friedman Test* shows significant differences between the observed variables so that the zero hypothesis is denied.

The Table below shows the correlation matrix of initial data used to evaluate the efficiency of insurance companies by insurance lines in Serbia.

Table 3 Correlation Matrix

Correlations							
		1	2	3	4	5	6
1 Number of companies	Pearson Correlation	1	.347	.463	.323	.188	.218
	Sig. (2-tailed)		.326	.178	.363	.603	.546
	N	10	10	10	10	10	10
2 Operating (functional) expenditures	Pearson Correlation	.347	1	.897**	.922**	.875**	.614
	Sig. (2-tailed)	.326		.000	.000	.001	.059
	N	10	10	10	10	10	10
3 Costs of providing the insurance services	Pearson Correlation	.463	.897**	1	.977**	.593	.857**
	Sig. (2-tailed)	.178	.000		.000	.071	.002
	N	10	10	10	10	10	10
4 Operating (functional) income	Pearson Correlation	.323	.922**	.977**	1	.650*	.872**
	Sig. (2-tailed)	.363	.000	.000		.042	.001
	N	10	10	10	10	10	10
5 Profit from investment activities	Pearson Correlation	.188	.875**	.593	.650*	1	.219
	Sig. (2-tailed)	.603	.001	.071	.042		.544
	N	10	10	10	10	10	10
6 Operating profit	Pearson Correlation	.218	.614	.857**	.872**	.219	1
	Sig. (2-tailed)	.546	.059	.002	.001	.544	
	N	10	10	10	10	10	10
**. Correlation is significant at the 0.01 level (2-tailed).							
*. Correlation is significant at the 0.05 level (2-tailed).							

Note: Author's calculations by using the SPSS software programme.

The correlation matrix shows that there is a significant correlation between the operating profit and costs of providing the insurance services and operating (functional) income at the level of statistical significance. Likewise, the correlation exists between the profit from investment activities and operating (functional) expenditures and operating (functional) income. In order to increase the operating profit, it is therefore necessary to manage as efficiently as possible the costs of providing the insurance services and operating (functional) income.

To approach the given topic as comprehensively as possible, we have briefly presented, in the Table 4, a ratio analysis of insurance companies by lines of insurance in Serbia 2019.

Table 4 Ratio Analysis

	Ratio between the operating (functional) income and operating (functional) expenditures	Ratio between the operating (functional) income and costs of providing insurance services	Operating profit by companies	Ratio between the operating profit and operating (functional) income	Share of operating (functional) income in the total
Pure life insurance	1.1406958	3.891503	273.4	12.33%	24.64%
Life insurance other than pure life	1.9110169	3.277616	107.4	47.63%	2.51%
Accident insurance and voluntary health insurance	1.4583541	2.088571	167	31.41%	6.50%
Motor vehicle insurance	1.304467	2.644328	174.1818	23.69%	8.99%
Insurance of vessels and transportation	2.4386617	1.842697	43.22222	59.30%	0.73%
Aircrafts insurance	1.1904762	0.19084	2.166667	52.00%	0.03%
Property insurance	1.5221397	2.627347	361.8182	33.46%	13.22%
Liability insurance	2.1981182	3.802299	1820.8	54.50%	37.13%
Credit and guarantee insurance	3.2948328	1.834179	94.25	69.56%	1.20%
Non-life insurance not classified in subgroups	2.4824253	1.348449	153.2727	59.68%	3.14%
Total	1.589263	3.07331	1766.684	37.31%	100.00%

The data in the table show that in Serbia, given the risk exposures, the operating profit declared as a percentage of operating (functional) income is the highest with the credit and guarantee insurance and the lowest with the pure life insurance. The insurance companies in Serbia realize 158 dinars of operating (functional) income by every 100 dinars of operating (functional) expenditures i.e. 307 dinars of operating (functional) income by every 100 dinars of the costs of providing insurance services. Operating profit by companies is the highest with liability insurance and the lowest with credit and guarantee insurance. The share of operating (functional) income of pure life insurance in the total income amounts to 24.64%. It is therefore at a lower level than the countries of the Western Europe and America (where it is over 60%).

The weight coefficients of the criterion were determined using the AHP method (Saaty, 2008). They are presented in the Table 5 and Figure 1.

Table 5 The weight coefficients of the criterion

Table	Criterion		Comment	Weights	+/-
	1	Number of companies		19.4%	3.4%
	2	Operating (functional) expenditures		13.7%	9.2%
	3	Costs of providing the insurance services		18.0%	5.7%
	4	Operating (functional) income		11.2%	4.1%
	5	Profit from investment activities		20.3%	7.6%
	6	Operating profit		17.4%	9.6%

Result	Eigenvalue			Lambda:	6.458	MRE:	44.0%
	Consistency Ratio	0.37	GCI: 0.26	Psi:	18.3%	CR: 7.3%	MRE est 42.8%

Matrix		Number of companies	Operating (functional) expenditures	Costs of providing the insurance services	Operating (functional) income	Profit from investment activities	Operating profit	Normalized Principal Eigenvector
		1	2	3	4	5	6	
Number of companies	1	1	2	1	2	1	1	19.35%
Operating (functional) expenditures	2	1/2	1	1/2	1	1/2	2	13.71%

Costs of providing the insurance services	3	1	2	1	2	1	1/2	18.01%
Operating (functional) income	4	1/2	1	1/2	1	1	1/2	11.25%
Profit from investment activities	5	1	2	1	1	1	2	20.30%
Operating profit	6	1	1/2	2	2	1/2	1	17.38%

Note: The calculations were made using the AHPS Software-Excel

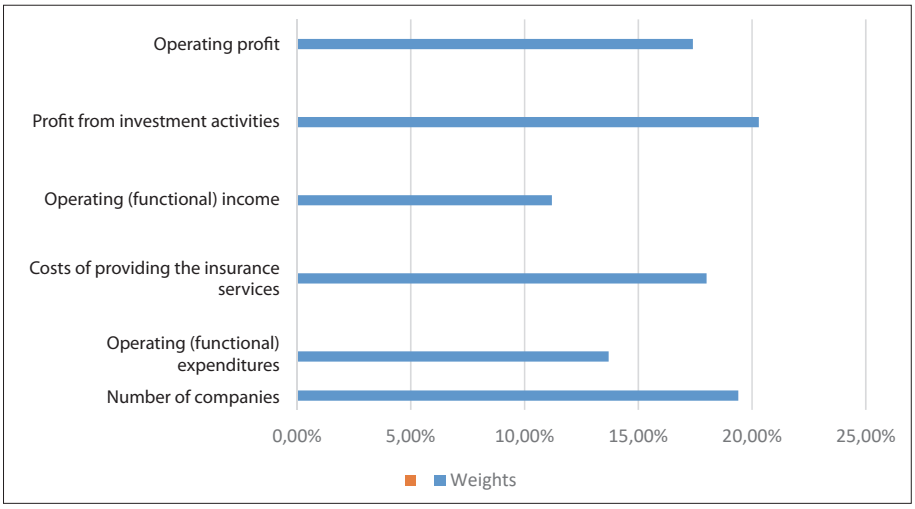

Figure 1 Weight Coefficient of Criterion

According to the importance of the criteria, profit from investment activities comes first. It is followed by the: number of companies, costs of providing insurance services, operating profit, operating (functional) expenditures and operating (functional) income. A more efficient management of profit from investment activities can have a significant impact on improving the efficiency of insurance companies by insurance lines in Serbia.

Table 6 shows the initial decision-making matrix.

Table 6 Initial Matrix

Initial Matrix						
Weights of Criteria	0.194	0.137	0.18	0.112	0.203	0.174
Kind of Criteria	1	-1	-1	1	1	1
	C1	C2	C3	C4	C5	C6
A1	10	19432	5696	22166	4689	2734
A2	10	1180	688	2255	308	1074
A3	11	4010	2800	5848	574	1837
A4	11	6201	3059	8089	381	1916
A5	9	269	356	656	126	389
A6	6	21	131	25	56	13
A7	11	7814	4527	11894	848	3980
A8	10	15198	8786	33407	1339	18208
A9	8	329	591	1084	206	754
A10	11	1138	2095	2825	207	1686
MAX	11	19432	8786	33407	4689	18208
MIN	6	21	131	25	56	13

Table 7 shows the normalized decision-making matrix.

Table 7 Normalized Matrix

Normalized Matrix						
Weights of Criteria	0.194	0.137	0.18	0.112	0.203	0.174
Kind of Criteria	1	-1	-1	1	1	1
	C1	C2	C3	C4	C5	C6
A1	0.8000	0.0000	0.3570	0.6633	1.0000	0.1495
A2	0.8000	0.9403	0.9356	0.0668	0.0544	0.0583
A3	1.0000	0.7945	0.6916	0.1744	0.1118	0.1002
A4	1.0000	0.6816	0.6617	0.2416	0.0701	0.1046
A5	0.6000	0.9872	0.9740	0.0189	0.0151	0.0207
A6	0.0000	1.0000	1.0000	0.0000	0.0000	0.0000
A7	1.0000	0.5985	0.4921	0.3556	0.1709	0.2180
A8	0.8000	0.2181	0.0000	1.0000	0.2769	1.0000
A9	0.4000	0.9841	0.9469	0.0317	0.0324	0.0407
A10	1.0000	0.9425	0.7731	0.0839	0.0326	0.0919

Table 8 shows the weighted comparability of sequence and S_i.

Table 8 Weighted Comparability of Sequence and S_i

Weighted Comparability Sequence and Si							
	C1	C2	C3	C4	C5	C6	Si
A1	0.1552	0.0000	0.0643	0.0743	0.2030	0.0260	0.5228
A2	0.1552	0.1288	0.1684	0.0075	0.0110	0.0101	0.4811
A3	0.1940	0.1088	0.1245	0.0195	0.0227	0.0174	0.4870
A4	0.1940	0.0934	0.1191	0.0271	0.0142	0.0182	0.4660
A5	0.1164	0.1352	0.1753	0.0021	0.0031	0.0036	0.4358
A6	0.0000	0.1370	0.1800	0.0000	0.0000	0.0000	0.3170
A7	0.1940	0.0820	0.0886	0.0398	0.0347	0.0379	0.4770
A8	0.1552	0.0299	0.0000	0.1120	0.0562	0.1740	0.5273
A9	0.0776	0.1348	0.1704	0.0036	0.0066	0.0071	0.4001
A10	0.1940	0.1291	0.1392	0.0094	0.0066	0.0160	0.4943
						SUM	4.6083
						MAX	0.5273
						MIN	0.3170

Table 9 shows the exponentially weighted comparability sequence and P_i.

Table 9 Exponentially Weighted Comparability Sequence and P_i

Exponentially Weighted Comparability Sequence and Pi							
	C1	C2	C3	C4	C5	C6	Pi
A1	0.9576	0.0000	0.8308	0.9551	1.0000	0.7185	4.4619
A2	0.9576	0.9916	0.9881	0.7385	0.5538	0.6099	4.8395
A3	1.0000	0.9690	0.9358	0.8224	0.6410	0.6702	5.0383
A4	1.0000	0.9488	0.9284	0.8529	0.5831	0.6751	4.9883
A5	0.9057	0.9982	0.9953	0.6412	0.4270	0.5092	4.4764
A6	0.0000	1.0000	1.0000	0.0000	0.0000	0.0000	2.0000
A7	1.0000	0.9321	0.8802	0.8906	0.6987	0.7672	5.1688
A8	0.9576	0.8117	0.0000	1.0000	0.7705	1.0000	4.5399
A9	0.8371	0.9978	0.9902	0.6794	0.4984	0.5729	4.5760
A10	1.0000	0.9919	0.9547	0.7576	0.4991	0.6602	4.8635
						SUM	44.9526
						MAX	5.1688
						MIN	2.0000

Table 10 and Figure 2 show the final aggregation and ranking.

Table 10 Final Aggregation and Ranking

						λ	0.5			
	Final Aggregation and Ranking									
	Alternatives	**Ka**	**Ranking**	**Kb**	**Ranking**	**Kc**	**Ranking**	**K**	**K**	**Final Ranking**
Pure life insurance	**A1**	0.1006	7	3.8801	7	0.8751	7	2.3176	2.3176	**7**
Life insurance other than pure life	**A2**	0.1074	5	3.9374	5	0.9341	5	2.3933	2.3933	**5**
Accident insur. and voluntary health insur.	**A3**	0.1115	2	4.0555	2	0.9700	2	2.4721	2.4721	**2**
Motor vehicle insurance	**A4**	0.1101	3	3.9642	4	0.9576	3	2.4248	2.4248	**3**
Insurance of vessels and transportation	**A5**	0.0991	9	3.6128	8	0.8624	9	2.2007	2.2007	**8**
Aircrafts insurance	**A6**	0.0468	10	2.0000	10	0.4068	10	1.1541	1.1541	**10**
Property insurance	**A7**	0.1139	1	4.0892	1	0.9912	1	2.5043	2.5043	**1**
Liability insurance	**A8**	0.1022	6	3.9334	6	0.8896	6	2.3516	2.3516	**6**
Credit and guarantee insurance	**A9**	0.1004	8	3.5500	9	0.8736	8	2.1858	2.1858	**9**
Non-life insurance not classified in subgroups	**A10**	0.1081	4	3.9910	3	0.9406	4	2.4203	2.4203	**4**

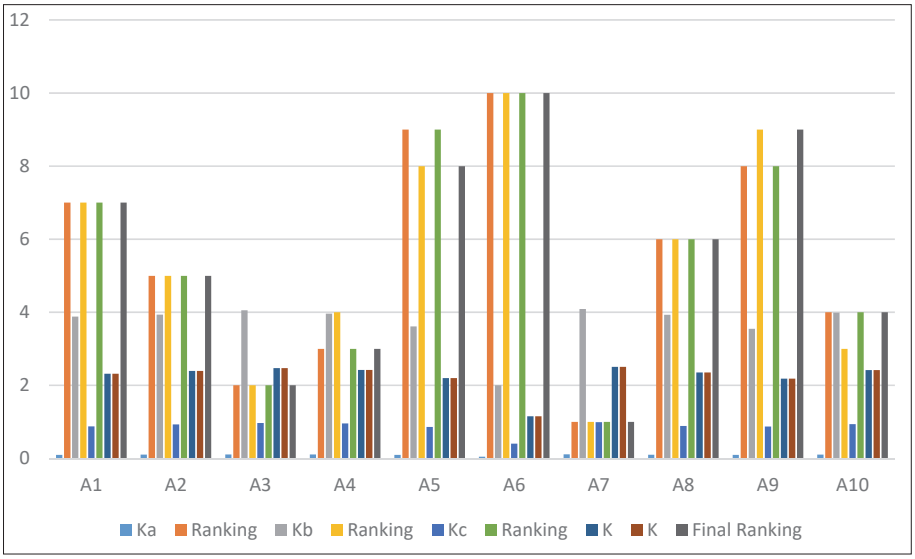

Figure 2 Ranking of Alternatives

Based on the results of the efficiency (performance) research of insurance companies by insurance lines in Serbia by the COCOSO method, it can be concluded that the best results are obtained in property insurance, followed by accident insurance and voluntary health insurance, motor vehicle insurance, non-life insurance not classified in subgroups, life insurance other than pure life, liability insurance, pure life insurance, insurance of vessels and transportation, credit and guarantee insurance and aircraft insurance.

Such efficiency (performance) ranking of insurance companies by insurance lines in Serbia was driven by a number of macro and micro factors (living standards, economic environment, political situation and others). According to our opinion, the awareness of the importance of insurance coverage is still at an unsatisfactory level. This is especially true for pure life insurance, which is at a lower level in Serbia than in the countries of developed market economies (the Western Europe and America, where the share of life insurance premium in premium total exceeds 60%). It is encouraging, however, that the awareness in Serbia is slowly awakened with the citizens who understand the importance and benefits maintaining the life insurance cover.

The standing of the agricultural insurance in Serbia is the same as that of the life insurance - at a low stage of development. The awareness of the importance of maintaining the agricultural insurance cover against the catastrophic events, nevertheless, has somewhat increased in Serbia.

IV. Conclusion

Based on the results of the efficiency (performance) research of insurance companies by insurance lines in Serbia using the COCOSO method, we can conclude that the best results were obtained in property insurance, followed by the accident insurance and voluntary health insurance , motor vehicle insurance, non-life insurance not classified in subgroups, life insurance other than pure life, liability insurance, pure life insurance, insurance of vessels and transportation credit and guarantee insurance and aircraft insurance.

A number of factors has driven such efficiency rankings of insurance companies by insurance lines in Serbia, including the living standards, economic climate, political situation, lack of awareness of the importance of insurance and the like.

In order to increase the future efficiency of insurance companies by insurance lines in Serbia, it is necessary to manage the operating (functional) expenditures, costs of providing the insurance services, operating (functional) income, profit from investment activities and operating profit in the future. The digitalisation of the entire business certainly plays a significant role in this respect.

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