ANALYSIS OF THE EFFICIENCY OF TRADE IN OIL DERIVATIVES IN SERBIA BY APPLYING THE FUZZY AHP-TOPSIS METHOD

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Abstract
The problem of analyzing trade efficiency is topical, significant and very complex. Multi-criteria decision-making has been increasingly used recently. With that regard, this paper analyzes the efficiency of trade in oil derivatives in Serbia with integrated application of the Fuzzy AHP-TOPSIS method. The results of this study show that of all the observed criteria (earnings, assets, capital, sales and net profit), the most significant are employees` earnings and capital respectively, and that the most effective companies are Daki Petrol, Oil Industry of Serbia (NIS), and Horizon Petrol. The most inefficient companies are Eko Serbia, Lukoil and Naftachem. In order to improve their efficiency in the future, it is necessary to manage assets, capital, sales and profits as efficiently as possible. Likewise, it is imperative that employees' earnings are at an “acceptable level” in accordance with the business conditions in a given business environment.
Keywords: employees` earnings, assets, capital, sales, profit.

1.INTRODUCTION

In order to obtain as accurate information as possible about the efficiency of trading companies, multi-criteria decision-making has been increasingly used. With this in mind, the subject of this paper is an analysis of the efficiency of oil derivatives trading in Serbia by integrated application of the Fuzzy AHP-TOPSIS method. Based on the real situation, the aim of this work is to propose adequate measures for improving the efficiency of oil derivatives trade in Serbia in the future.

When it comes to the general problem of the analysis of the efficiency (primarily in the manufacturing and financial sectors) by applying Fuzzy AHP-TOPSIS method, the literature is extensive. However, there are very few papers dedicated to the application of Fuzzy AHP-TOPSIS method in the analysis of trading companies` efficiency (Keener, 2013; Martino et al. 2017). This is especially true of literature in Serbia and, as far as we know, there is almost no comprehensive work dedicated to the application of Fuzzy AHP-TOPSIS method in the analysis of the efficiency of trading companies, except for partial consideration in some papers dealing with efficiency measurement and cost management (Lukic, 2011; Lukic, 2018a,b; Lukic, 2019). Gap should be partly filled by this paper devoted to the analysis of the

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efficiency of trade in oil derivatives in Serbia by applying the Fuzzy AHP - TOPSIS method, thus making useful scientific and professional contribution.

The basic hypothesis of the research in this paper is that continuous monitoring of the efficiency of all companies, including trade companies, and taking adequate measures is a key basis for improvement in the future. Speaking of methodology, in addition to statistical analysis, econometric analysis and other mathematical methods and models, the analysis of the efficiency of trading companies (in our case – sales of oil derivatives in Serbia) can be significantly improved by the integrated use of the Fuzzy AHP-TOPSIS method. In order to conduct the analysis in this paper, we collected the data from the Business Registers Agency of the Republic of Serbia which are "manufactured" in accordance with relevant international standards, so that there are no restrictions on international comparability.

2. FUZZY AHP METHOD

Multi-criteria decision making by applying the AHP (Analytical Hierarchical Process) method was developed with the fuzzy approach, which is known as the Fuzzy AHP method. The fuzzy AHP method combines the fuzzy concept with the AHP method. This method was developed by Chang (1996) using triangular fuzzy numbers (TFN). Let us denote the set of objects by $X = (x_1, x_2, \ldots, x_n)$, and the set of goals by $U = (u_1, u_2, \ldots, u_m)$. According to the Extended Analysis methodology (developed by Chang), an extended target analysis u_{ij} is performed for each object. The value of the extended analysis m for each object is expressed as follows:

$$M_{gi}^1, M_{gi}^2, M_{gi}^m, \quad i = 1,2, \ldots, n \qquad 1)$$

where $m_{g,}^j\ j = 1,2, \ldots, m$ are fuzzy triangle numbers.

Figure 1 shows a fuzzy triangle number, as a combination of two lines.

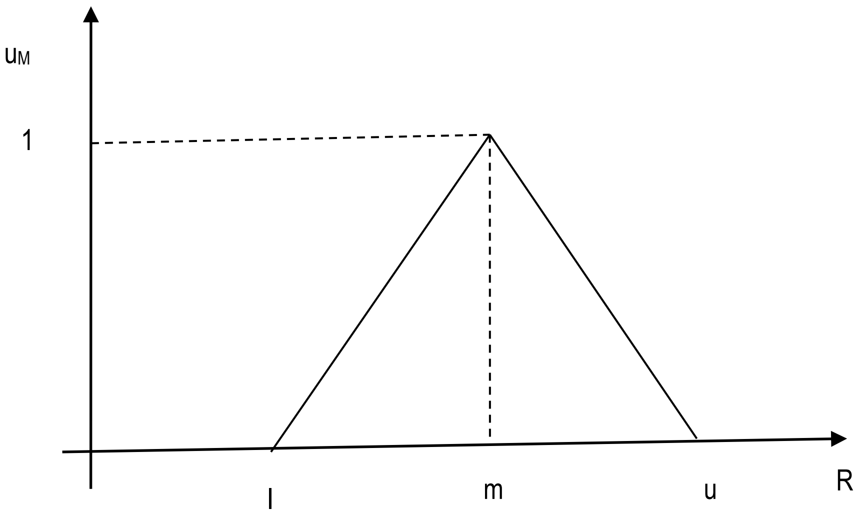

FIGURE 1. TRIANGULAR FUZZY NUMBER *M = (l, m, u)*

Source: van Laarhoven, P. J. M., and Pedrycs, W. (1983)

Chang's extended analysis contains the following steps (Chang, 1992, 1996; Zhu et al., 1999; Büyüközkan et al., 2004):

Step 1: fuzzy extensions values (fuzzy synthetic exten) for the *i* object is defined as

$$S_i = \sum_{j=1}^{m} M_{gi}^{j} \times \left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j}\right]^{-1} \qquad (2)$$

In order to obtain expression

$$\sum_{j=1}^{m} M_{gi}^{j}$$

it is necessary to perform additional fuzzy operations with *m* values of the extended analysis such that

$$\sum_{j=1}^{m} M_{gi}^{j} = \left(\sum_{j=1}^{m} l_j, \sum_{j=1}^{m} m_j, \sum_{j=1}^{m} u_j\right) \qquad (3)$$

and to obtain expression

$$\left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j}\right]^{-1}$$

it is necessary to make additional fuzzy operations with M_{gi}^{j} $(j = 1,2,\dots,m)$values so that

$$\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j} = \left(\sum_{j=1}^{m} l_j, \sum_{j=1}^{m} m_j, \sum_{j=1}^{m} u_j\right) \qquad (4)$$

and then determine the inverse vector in equation (4) as

$$\left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j}\right]^{-1} = \left(\frac{1}{\sum_{i=1}^{n} u_i}, \frac{1}{\sum_{i=1}^{n} m_i}, \frac{1}{\sum_{i=1}^{n} l_i}\right) \qquad (5)$$

Step 2: Degree of possibility$M_2 = (l_2, m_2, u_2) \geq M_1 = (l_1, m_1, u_1)$ is defined as

$$V(M_2 \geq M_1) = sup\left[min\left(u_{m1}(x), u_{m2}(y)\right)\right] \qquad (6)$$

$$y \geq x$$

and can be expressed equivalently as

$$V(M_2 \geq M_1) = hgt\,(M_1 \cap M_2) = u_{m2}\,(d) \qquad (7)$$

$$= \begin{cases} 1 \ ako\ je m_2 \geq m_1 \\ 0 \quad ako\ je\ l_1 \geq u_2 \\ \dfrac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)} \end{cases} \qquad (8)$$

where d is the ordinate of the largest cross section at point D between u_{m1} and u_{m2} (Figure 2). By comparing M_1 and M_2 we can see that the required values are $V(M_1 \geq M_2)$ and $V(M_2 \geq M_1)$.

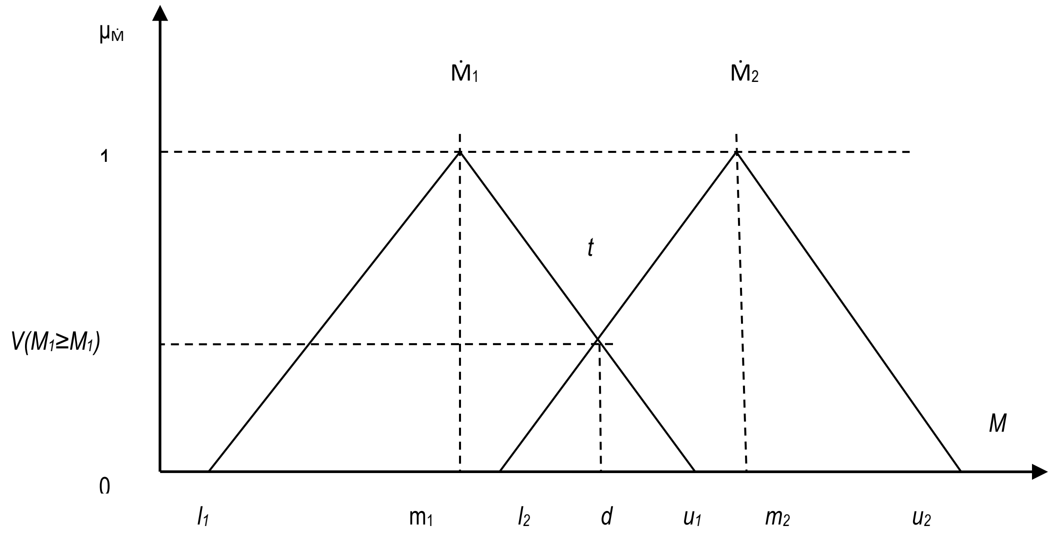

FIGURE 2. CROSS SECTION BETWEEN M_1 AND M_2

Source: author adaptation

Step 3: The degree of possibility for a convex fuzzy number, which should be greater than *k* convex fuzzy number M_i (i = 1,2,…, k), may be defined as:

$$V(M \geq M_1, M_2, \dots, M_k) = V[(M \geq M_1) \; and \; (M \geq M_2) \; and \dots and \; (M \geq M_k)]$$

$$= \min V(M \geq M_1) \qquad (9)$$

Let us assume that:

$$d'(A_i) = \min V(S_i \geq S_k) \qquad (10)$$

$For \; k = 1,2, \dots, n; k \neq i$. Then the weighted vector is given as:

$$W' = [d'(A_1), d'(A_2), \dots, d'(A_n)]^T \qquad (11)$$

where Ai ($i = 1,2,\dots,n$) are *n* elements.

Step 4: After normalization, normalized vectors are:

$$W = [d(A_1), d(A_2), \dots, d(A_n)]^T \qquad (12)$$

where *W* does not represent fuzzy number.

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It is considered that the disadvantage of the Fuzzy AHP method is that is does not take into account the degree of consistency, i.e. does not calculate its value. It can be calculated by taking crisp values. Checking the degree of consistency of the Fuzzy AHP method can be done by applying the Kwong method (Kwong and Bai, 2003). The triangle number denoted as $M = (l, m, u)$ should be defuzzied as follows:

$$M_{-crsp} = \frac{(4m + l + u)}{6} \qquad (13)$$

and apply the standard procedure for determining the degree of consistency as in the classical AHP method.

The application of the Fuzzy AHP method mitigates the shortcomings of the classic AHP method (Saaty, 1970, 1980, 2008, 1986; Saaty and Vargas, 2001; Harker and Vargas, 1987). Different fuzzy triangular comparison scales have been developed for this purpose, so that the decision maker can evaluate the significance of the criteria or alternative much closer and easier and thus minimize his "subjectivity" (Table 1).

TABLE 1. TRIANGULAR FUZZY SCALE (Chang, 1996)

Linguistic variable	Triangular fuzzy scale	Triangular fuzzy reciprocal scale
Just equal	(1, 1, 1)	(1, 1, 1)
Equally important	(1/2, 1, 3/2)	(2/2, 1, 2)
Weakly important	(1, 3/2, 2)	(1/2, 2/3, 1)
Strongly more important	(3/2, 2, 5/2)	(2/5, 1/2, 2/3)
Very strongly more important	(2, 5/2, 3)	(1/3, 2/5, 1/2)
Absolutely more important	(5/2, 3, 7/2)	(2/7, 1/3, 2/5)

Source: Honarbakhsh et al., (2018)

3. TOPSIS METHOD

The TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) method has been used very successfully in evaluating companies' financial performance (Üçüncü et al., 2018). It is a multi-criteria decision-making technique first developed and applied by Hwang and Yoon (1981, 1995). According to this method, alternatives are determined by their distances from the ideal solution. The goal is to choose the optimal alternative that is closest to the ideal solution, that is, farthest from the negative ideal solution (Young, 1994). A positive ideal solution maximizes utility, that is, minimizes costs (in relation to a given problem). In contrast, a negative ideal solution maximizes costs, i.e. minimizes utility (Yousefi and Hadi-Vencheh, 2010; Wang and Lee, 2007).

The TOPSIS method consists of 6 steps (Üçüncü et al., 2018).

Step 1: Create an Initial Matrix

The initial matrix A*ij* "*m*" denotes the alternative number and "*n*" the number of criteria:

$$A_{ij} = \begin{vmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{m1} & a_{m2} & \cdots & a_{mn} \end{vmatrix}$$

Step 2: Formation of weighted Normalized Decision Matrix

The normalized decision matrix (R_{ij}; $i = 1,\dots, m$; $j=1,\dots, n$) is determined by Equation (14) with the elements of the matrix A_{ij}:

$$r_{ij} = \frac{a_{ij}}{\sqrt{\sum_{i=1}^{m} a_{ij}^2}} \qquad (14)$$

$$t = 1,2,3,\dots,m \qquad j = 1,2,3,\dots,n$$

$$R_{ij} = \begin{vmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{vmatrix}$$

In Equation (15) the weighted measure "*j*" is represented by W_{ij}. The weighted normalized decision matrix (V_{ij}; $i = 1,\dots, m$; $j = 1,\dots, n$) was determined using Equation (15) with the elements of the normalized matrix:

$$V_{ij} = W_{ij} * r_{ij} \qquad (15)$$

$$i = 1,2,3,\dots,m \qquad j = 1,2,3,\dots,n$$

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Step 3: Determine the Positive and Negative-Ideal Solution

The value of the positive-ideal solution (A +) and the negative-ideal solution (A-) is determined from the value of the weighted normalized matrix (V_{ij}). A^+ is better and A^- is a worse performance score.
The value of the positive-ideal solution (A^+) and the negative-ideal solution (A^-) is determined as follows (equation (7) and (8) respectively):

$$A^+ = \{v_i^+, \dots, v_n^+\} = \left\{\left(\max_i v_{ij}, j \in j\right)\left(\min_i v_{ij}, j \ \in j'\right)\right\} \ i = 1,2,\dots,m \qquad (16)$$

$$A^- = \{v_i^-, \dots, v_n^-\} = \left\{\left(\min_i v_{ij}, j \in j\right)\left(\max_i v_{ij}, j \in j'\right)\right\} \ i = 1,2,\dots,m \qquad (17)$$

where *j* is related to the benefit criterion, and *j'* is related to the cost criterion.

Step 4: Determination of special measures (i.e. distance of alternatives from ideal and negative-ideal solution)
The distance from the positive-ideal solution (S_i^+) and the negative-ideal solution (S_i^-) for each alternative according to the given criterion is determined using equations (18) and (19).

$$S_i^+ = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^+)^2} \qquad (18)$$

$$S_i^- = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^-)^2} \qquad (19)$$

$$i = 1,2,3,\dots,m \qquad j = 1,2,3,\dots,n$$

Step 5: Determination of the coefficient of relative closeness to the ideal solution

Specific measures of positive-ideal solution (S_i^+) and negative-ideal solution (S_i^-) were used to determine the relative closeness to the ideal solution (C_i^+) for each decision point. C_i^+ represents the relative closeness to the ideal solution and takes a value in the range $0 \le C_i + \le 1$. "C_i^+" = 1 indicates the relative closeness to the positive-ideal solution. " C_i^+" = 0 indicates relative closeness to the negative-ideal solution.
The relative closeness to the ideal solution (C_i^+; i = 1,…, m; *j = 1,…, n*) was determined by using equation (20):

$$C_i^+ = \frac{S_i^-}{S_i^- + S_i^+} \quad (20)$$

$$i = 1,2,3, \dots, m$$

Step 6: Sorting of the alternatives according to relative superiority

Determining the relative superiority of the score represents the company's performance. High scores correspond with better performance. The results can be used to determine company rankings within the industry (Üçüncü et al., 2018).

4. MEASURING THE EFFICIENCY OF TRADE IN OIL DERIVATIES IN SERBIA

We will perform the Fuzzy AHP - TOPSIS method for measuring the efficiency of trade in oil derivatives in Serbia. In doing so, we will use the following criteria: employees' earnings, assets, capital, sales and net profits. Table 2 shows the original numerical values of the respective criteria.

TABLE 2. SELECTED CRITERIA FOR MEASURING THE EFFICIENCY OF TRADE IN OIL DERIVATIVES IN SERBIA USING THE FUZZY AHP - TOPSIS METHOD, 2018

	Employees' earnings (million dinars)	Assets (millions of dinars)	Capital (million dinars)	Sales (million dinars)	Net profit (million dinars)
Oil industry of Serbia - NIS	15245	401474	81530	258523	26067
Lukoil	436	5362	7837	33480	-248
MOL Serbia	312	15882	10426	42812	655
OMV Serbia	200	12534	8254	35293	813
EKO Serbia	205	7911	3728	20337	199
Knez Petrol	743	7295	2082	43317	388
Euro Petrol	97	2863	979	9401	80
Evolucija 2004	48	1684	73	8560	16
Naftachem	130	4096	1796	15118	136

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Euro Gas	89	2328	1004	3248	5
Standard Gas	73	1401	100	297	-253
Daki Petrol	14	325	38	76	-98
Horizon Energy	8	519	515	35	8
Miletić Petrol	28	2419	415	14791	70
SPEED	42	2357	1466	12184	30

Source: Business Registers Agency of the Republic of Serbia

Table 3 presents descriptive statistics of the observed criteria in the context of measuring the efficiency of trade in oil derivatives in Serbia by application of the Fuzzy AHP - TOPSIS method.

TABLE 3. DESCRIPTIVE STATISTICS OF OBSERVED CRITERIA IN THE CONTEXT OF MEASURING THE EFFICIENCY OF OIL DERIVATIVES TRADE IN SERBIA BY APPLICATION OF THE FUZZY AHP - TOPSIS METHOD

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Employees' earnings	15	8.00	15245.00	1178.0000	3896.52730
Assets	15	325.00	401474.00	31230.0000	102522.66107
Capital	15	38.00	81530.00	8016.2000	20611.24118
Sales	15	35.00	258523.00	33164.8000	64138.79279
Net profit	15	-253.00	26067.00	1857.8667	6703.72901
Valid N (listwise)	15				

Source: Author's calculation performed by application of the SPSS software

The data in the table shows that by all criteria the best company is the Oil Industry of Serbia (NIS). It produces above-average results.

Table 4 shows the correlation matrix of observed criteria in the context of measuring the efficiency of trade in oil derivatives in Serbia by application of the Fuzzy AHP - TOPSIS method.

TABLE 4. CORRELATION MATRIX OF OBSERVED CRITERIA IN THE CONTEXT OF MEASURING THE EFFICIENCY OF TRADE IN OIL DERIVATIVES IN SERBIA BY APPLICATION OF THE FUZZY AHP - TOPSIS METHOD

Correlations						
		Employees' earnings	Assets	Capital	Sales	Net profit
Employees' earnings	Pearson Correlation	1	.999**	.989**	.981**	.999**
	Sig. (2-tailed)		.000	.000	.000	.000
	N	15	15	15	15	15
Assets	Pearson Correlation	.999**	1	.992**	.980**	1.000**
	Sig. (2-tailed)	.000		.000	.000	.000
	N	15	15	15	15	15
Capital	Pearson Correlation	.989**	.992**	1	.990**	.990**
	Sig. (2-tailed)	.000	.000		.000	.000
	N	15	15	15	15	15
Sales	Pearson Correlation	.981**	.980**	.990**	1	.978**
	Sig. (2-tailed)	.000	.000	.000		.000
	N	15	15	15	15	15
Net profit	Pearson Correlation	.999**	1.000**	.990**	.978**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	15	15	15	15	15
**. Correlation is significant at the 0.01 level (2-tailed).						

Source: Author's calculation performed by application of the SPSS software

The data in the table below show a high correlation between the observed criteria in the context of measuring the efficiency of oil derivatives trade in Serbia using the Fuzzy AHP - TOPSIS method.

In further presentations of the treated problem using the Fuzzy AHP method we will determine the weight coefficients of the criteria used in the context of measuring the efficiency of trade in oil derivatives in Serbia using the Fuzzy AHP-TOPSIS method. (Data processing was performed using Chang Fuzzy AHP with Consistency Ratio.xlsx.)

Table 5 shows the linguistic scale of values used in this paper.

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TABLE 5. MEMBERSHIP FUNCTION OF LINGUISTIC SCALE (EXAMPLE)

Fuzzy number	Linguistic	Scale of fuzzy number
9	Perfect	(8,9,10)
8	Absolute	(7,8,9)
7	Very good	(6,7,8)
6	Fairly good	(5,6,7)
5	Good	(4,5,6)
4	Preferable	(3,4,5)
3	Not bad	(2,3,4)
2	Weak advantage	(1,2,3)
1	Equal	(1,1,1)

Source: Chang Fuzzy AHP with Consistency Ratio.xlsx

Table 6 shows the initial comparison matrix.

TABLE 6. INITIAL COMPARISON MATRIX

Initial Comparison Matrix																			
Left Criteria Is Greater										Right Criteria Is Greater									
	Perfect	Absolute	Very good	Fairly good	Good	Preferable	Not bad	Weak	Equal	Weak	Not bad	Preferable	Good	Fairly good	Very good	Absolute	Perfect		Total Number of
A							4	3	1	3								B	12
A							3	2	1	2	3							C	12
A							4	2	1	2	2							D	12
A							3	3	1	2	2							E	12
B							3	3	1	2	2							C	12
B							2	3	1	2	2							D	12
B							3	3	1	2	2							E	12
C							5	3	1	1								D	12
C							3	3	1	2	2							E	12
D						4	3	3	1	2		4						E	12

Source: Author's calculation performed by application of Chang Fuzzy AHP With Consistency Ratio.xlsx. Some criteria labels are: A - employees' earnings, B - assets, C - capital, D - sales and E - net profit

Table 7 shows the integrated fuzzy comparison matrix.

TABLE 7. INTEGRATED FUZZY COMPARISON MATRIX

Integrated Fuzzy Comparison Matrix															
	A			B			C			D			E		
A	1	1	1	0.9573	1.4422	2.0891	0.7002	1.0000	1.4282	0.8327	1.2009	1.6984	0.7859	1.1610	1.6581
B	0.4787	0.6934	1.0446	1	1	1	0.7859	1.1610	1.6581	0.7418	1.0595	1.4772	0.7859	1.1610	1.6581
C	0.7002	1.0000	1.4282	0.6031	0.8613	1.2723	1	1	1	1.2181	1.7741	2.3450	0.7859	1.1610	1.6581
D	0.5888	0.8327	1.2009	0.6769	0.9439	1.3480	0.4264	0.5637	0.8210	1	1	1	0.8352	1.3943	2.2067
E	0.6031	0.8613	1.2723	0.6031	0.8613	1.2723	0.6031	0.8613	1.2723	0.4532	0.7172	1.1973	1	1	1

	Fuzzy Sum of Each Row			Fuzzy Synthetic Extent		
	4.2762	5.8042	7.8738	0.1222	0.2257	0.4108
	3.7924	5.0749	6.8381	0.1083	0.1974	0.3568
	4.3073	5.7964	7.7036	0.1230	0.2254	0.4020
	3.5274	4.7346	6.5766	0.1008	0.1841	0.3431
	3.2624	4.3011	6.0144	0.0932	0.1673	0.3138
Sum	19.1656	25.7112	35.0066			

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Degree of Possibility of Mi>Mj					Degree of Possibility (Mi)	normalization		
	1	1	1	1	1	0.2223	0.222	weights of criteria
0.892		0.893	1	1	0.892	0.1983	0.198	
0.999	1		1	1	0.999	0.2220	0.222	
0.842	0.947	0.842		1	0.842	0.1871	0.187	
0.766	0.872	0.766	0.927		0.766	0.1703	0.170	
					4.499	1		
					Sum			

Consistency Ratio (CRm)			0.0173	Compare with 0.1, They should be less than 0.1
Consistency Ratio (CRg)			0.0439	

Source: Author's calculation performed by application of Chang Fuzzy AHP With Consistency Ratio.xlsx. Some criteria labels are: A - employee earnings, B - assets, C - capital, D - sales and E - net profit

The data in the table below shows that in this particular case, the most important criterion is employees' salaries and capital, respectively.

We will use the obtained weights coefficients of the observed criteria using the Fuzzy AHP method when applying the TOPSIS method in evaluating the efficiency of trade in oil derivatives in Serbia. (Data processing using the TOPSIS method was performed using ARAS Software.xlsx.)

Table 8 shows the initial decision matrix.

TABLE 8. INITIAL DECISION MATRIX

weights of criteria	0.222	0.198	0.222	0.187	0.17
kind of criteria	-1	-1	-1	1	1
	C1	C2	C3	C4	C5
Oil industry of Serbia(NIS)	15245	401474	81530	258523	26067
Lukoil	436	5362	7837	33480	-248
MOL Serbia	312	15882	10426	42812	655

OMV Serbia	200	12534	8254	35293	813
EKO Serbia	205	7911	3728	20337	199
Knez Petrol	743	7295	2082	43317	388
Euro Petrol	97	2863	979	9401	80
Evolucija 2004	48	1684	73	8560	16
Naftachem	130	4096	1796	15118	136
Euro Gas	89	2328	1004	3248	5
Standard Gas	73	1401	100	297	-253
Daki Petrol	14	325	38	76	-98
Horizon Energy	8	519	515	35	8
Miletić Petrol	28	2419	415	14791	70
SPEED	42	2357	1466	12184	30

MAX	15245	401474	81530	258523	26067
MIN	8	325	38	35	-253
0-Optimal Value	8	325	38	258523	26067

Source: Author's calculation performed by application of ARAS Software.xlsx. Certain criteria labels mean: C1 - employee earnings, C2 - assets, C3 - capital, C4 - sales and C5 - net profit

Table 9 shows the normalized decision matrix.

TABLE 9. NORMALIZED DECISION MATRIX

weights of criteria	0.222	0.198	0.222	0.187	0.17
kind of criteria	-1	-1	-1	1	1
	C1	C2	C3	C4	C5
0-Optimal Value	0.2708	0.2598	0.3094	0.3420	0.4780
Oil industry of Serbia (NIS)	0.0001	0.0002	0.0001	0.3420	0.4780
Lukoil	0.0050	0.0157	0.0015	0.0443	0
MOL Serbia	0.0069	0.0053	0.0011	0.0566	0.0120
OMV Serbia	0.0108	0.0067	0.0014	0.0467	0.0149
EKO Serbia	0.0106	0.0107	0.0032	0.0269	0.0036
Knez Petrol	0.0029	0.0116	0.0056	0.0573	0.0071
Euro Petrol	0.0223	0.0295	0.0120	0.0124	0.0015
Evolucija 2004	0.0451	0.0501	0.1611	0.0113	0.0003
Naftachem	0.0167	0.0206	0.0065	0.0200	0.0025

Euro Gas	0.0243	0.0363	0.0117	0.0043	0.0001
Standard Gas	0.0297	0.0603	0.1176	0.0004	0
Daki Petrol	0.1548	0.2598	0.3094	0.0001	0
Horizon Energy	0.2708	0.1627	0.0228	0.0000	0.0001
Miletić Petrol	0.0774	0.0349	0.0283	0.0196	0.0013
SPEED	0.0516	0.0358	0.0080	0.0161	0.0006

Source: Author's calculation performed by application of ARAS Software.xlsx. Certain criteria labels mean: C1 - employee earnings, C2 - assets, C3 - capital, C4 - sales and C5 - net profit

Table 10 shows the normalized decision weight matrix.

TABLE 10. NORMALIZED WEIGHT DECISION MATRIX

	C1	C2	C3	C4	C5
0-Optimal Value	0.0601	0.0514	0.0687	0.0639	0.0813
Oil industry of Serbia (NIS)	0.0000	0.0000	0.0000	0.0639	0.0813
Lukoil	0.0011	0.0031	0.0003	0.0083	0
MOL Serbia	0.0015	0.0011	0.0003	0.0106	0.0020
OMV Serbia	0.0024	0.0013	0.0003	0.0087	0.0025
EKO Serbia	0.0023	0.0021	0.0007	0.0050	0.0006
Knez Petrol	0.0006	0.0023	0.0013	0.0107	0.0012
Euro Petrol	0.0050	0.0058	0.0027	0.0023	0.0002
Evolucija 2004	0.0100	0.0099	0.0358	0.0021	0.0000
Naftachem	0.0037	0.0041	0.0015	0.0037	0.0004
Euro Gas	0.0054	0.0072	0.0026	0.0008	0.0000
Standard Gas	0.0066	0.0119	0.0261	0.0001	0
Daki Petrol	0.0344	0.0514	0.0687	0.0000	0
Horizon Energy	0.0601	0.0322	0.0051	0.0000	0.0000
Miletić Petrol	0.0172	0.0069	0.0063	0.0037	0.0002
SPEED	0.0115	0.0071	0.0018	0.0030	0.0001

Source: Author's calculation performed by application of ARAS Software.xlsx. Certain criteria labels mean: C1 - employee earnings, C2 - assets, C3 - capital, C4 - sales and C5 - net profit

Table 11 and Figure 3 show the ranked decision matrix.

TABLE 11. RANKED DECISION MATRIX

	S	K	K	Ranking
0-Optimal Value	0.3255	1	1	
Oil industry of Serbia (NIS)	0.1453	0.4465	0.4465	*2*
Lukoil	0.0128	0.0394	0.0394	*14*
MOL Serbia	0.0155	0.0476	0.0476	*11*
OMV Serbia	0.0153	0.0471	0.0471	*12*
EKO Serbia	0.0108	0.0332	0.0332	*15*
Knez Petrol	0.0161	0.0495	0.0495	*8*
Euro Petrol	0.0160	0.0493	0.0493	*9*
Evolucija 2004	0.0579	0.1778	0.1778	*4*
Naftachem	0.0134	0.0412	0.0412	*13*
Euro Gas	0.0160	0.0492	0.0492	*10*
Standard Gas	0.0447	0.1373	0.1373	*5*
Daki Petrol	0.1545	0.4747	0.4747	*1*
Horizon Energy	0.0974	0.2994	0.2994	*3*
Miletić Petrol	0.0343	0.1053	0.1053	*6*
SPEED	0.0234	0.0720	0.0720	*7*

Source: Author's calculation performed by application of ARAS Software.xlsx.

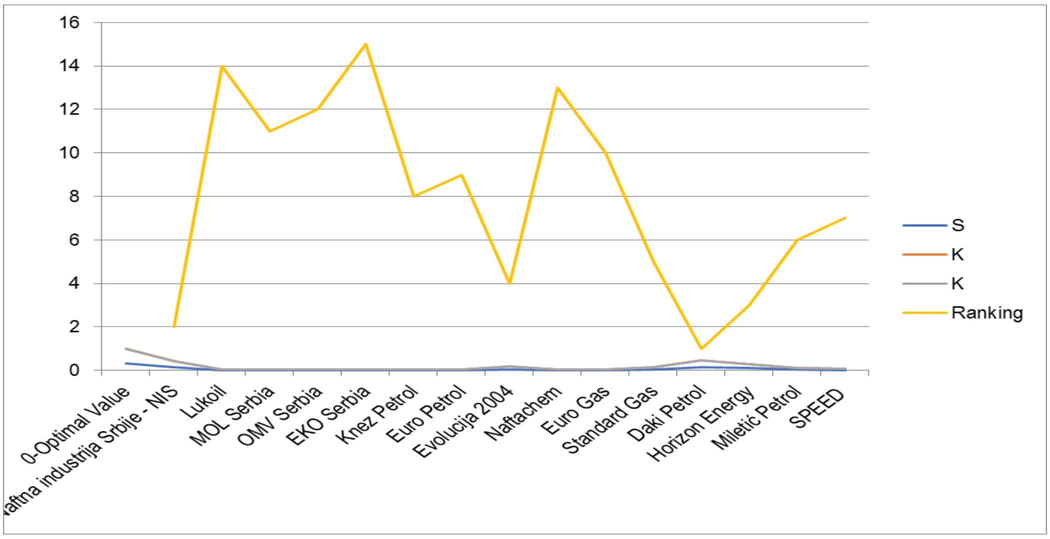

FIGURE 3. RANKED DECISION MATRIX
Source: Author's calculation

Therefore, the most efficient are Daki Petrol, Oil Industry of Serbia (NIS) and Horizon Petrol. The most inefficient companies are Eko Serbia, Lukoil and Naftachem. Other observed companies in the oil derivatives sector are “moderately” efficient.

5.CONCLUSIONS

Based on the conducted analysis of the efficiency of trade in oil derivatives in Serbia by integrated Fuzzy AHP-TOPSIS method, it can be concluded that of all the observed criteria (employees' earnings, assets, capital, sales and net profit) the most significant are employees' earnings and capital, respectively.

Furthermore, the most efficient companies are Daki Petrol, Oil Industry of Serbia (NIS), and Horizon Petrol while the most inefficient companies are Eko Serbia, Lukoil and Naftachem. Other observed companies which do trading business in oil derivatives in Serbia are “moderately” efficient.

In order to improve their efficiency in the future, it is necessary to manage assets, capital, sales and profits as efficiently as possible. Also, it is necessary that employees' earnings are at an "acceptable level" in accordance with the business conditions in a given business environment.

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