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USING OF MULTI-CRITERIAL EVALUATION METHODS TO ASSESS POSITION OF THE OBJECT IN THE MARKET

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Abstract: The article deals with the evaluation of the firm's position. Recognition of market position among competitors but also among customers is important for the development of the company. A comparison can be made by using multi-criterial methods. The ranking of companies is based on different methods (method of simple order, weighted order sum method, point methods, standardized variable method). Compliance order will be assessed by the rank correlation coefficients. Acquired assessment of market state allows us to design a strategic.

1 Introduction

Currently in the market place exists a huge competition as naturally companies want to be one step ahead of their competitors. Know the market place as well as environment of customers, suppliers and the market competition is important for every company. The position of the company in terms of financial performance data and success in the market can be traced countless analyzes. Evaluation of the position will serve us to map out a strategy for future development. When comparing a distinction in the content and scope of a comprehensive comparison (overall results of companies) and partial matching (an area of management). In the case of intercompany (the pooling) comparisons should be considered a company belonging to the industry. In the selection of indicators should respect the principle of comparability. In selecting the sample which compares preserve material, time, size and formal comparability [1].

2 Indicators of financial and economic analysis

Area of financial and non-financial indicators, through which it is possible to identify the performance properties of companies is very wide. The most common indicators that characterize the performance of the company are mainly financial indicators which can be divided into absolute and relative [2].

Absolute indicators:

- EBET – Earnings before taxes,
- EAT – Earnings after taxes,
- Re – Revenue,
- PH – value added,
- Cash-flow.

The disadvantage of these indicators is that they can not be used for inter-comparison. But it can be eliminated, it means that these values are placed in proportion to some baseline. When analyzing the indicators should be taken into account internal and external influences. For example, the cost increase may be due to an investment that will yield the company, but also inefficiency [3].

Among the relative indicators are indicators of profitability, activity, liquidity. When indicators of profitability may explanatory power to distort net profit. Liquidity ratios have high explanatory power.

Profitability indicators:

- ROS – Return on Sales,
- RA Return on Assets,
- ROE Return on Equity,

Activityy indicators:

- CT - Capital Turnover,
- TC - Turnaround Commitments,
- TTOS - Total turnover of stocks,
- AOR - The amount of receivables,

Liquidity indicators:

- TL - Total Liquidity,
- IL - Immediate liquidity,
- QR - Quick ratio,
- I – Insolvency.

Among the indicators above the contribution analysis: ROS, ROE, CT , Tl. (Table 1)

Table 1 Financial indicators

Object	ROS	ROE	CT	TL
1.	**0,162**	**0,0915**	0,34	1,96
2.	0,154	0,068	0,35	2,19
3.	0,103	0,0471	**0,62**	1,25
4.	0,135	0,0835	0,51	1,61
5.	0,156	0,0694	0,17	1,23
6.	0,128	0,0562	0,29	0,77
7.	0,132	0,0789	0,46	0,75
8.	0,089	0,0715	0,52	1,2
9.	0,105	0,0697	0,15	1,56
10.	0,085	0,08	0,55	**0,67**

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3 Multi-criteria evaluation methods

To assess the position of companies (enterprises) on the market, it is possible to use different statistical methods [4]:

- Statistical location and variability (arithmetic mean - average, mode, median, standard deviation, variance, coefficient of variation).
- Methods of statistical analysis (determination of confidence intervals, parametric and non-parametric tests).
- Methods of qualitative and quantitative character interrelation analysis (regression and correlation analysis).
- Multi-criteria evaluation methods - comparison of companies based on several variables (order method, point method, the standardized variable method).

Which were Table 2 Basic characteristics

Characteristics	ROS	ROE	CT	TL
average value	0,1249	0,0716	0,3960	1,3190
standard deviation	0,0267	0,0123	0,1531	0,4884
Maximum	0,162	0,0915	0,62	2,19
Minimum	0,085	0,0471	0,15	0,67
Coefficients of variation	21,35%	17,23%	38,67%	37,03%

For purpose of comparison, we selected four indicators in ten objects (companies) which were compared by means of four methods [5]. Compliance was assessed by serial order coefficients. Table 2 shows the basic statistical characteristics of the monitored parameters.

3.1 Method of simple order (SOM)

Method of simple order is the simplest method of ranking, which evaluates the position of an object according to the serial number of the range objects. An indicator of productivity (ROS, ROE, CT) in which we try to maximize the ranking is determined from *1,2 ... n* by the number of objects, so that we assign the lowest value to the object with the highest value achieved. Performance indicator (TL) in which we try to minimize the ranking is determined from *1,2 ... n* by the number of objects, so that we assign the highest value to the object with the lowest value achieved. Integral indicator (d_i) is designated as a simple sum of the order [6]. The best is the object for which the integral indicator (d_i) is maximum, in case of indicators equality, an average of the order from objects which reached this value is carried out. The advantage of this method is the simplicity but it does not quantify, how much higher or lower the object is than the second one (Table 3).

Table 3 Method of simple order

Object	ROS	ROE	CT	TL	d_i	Order
1.	10	10	4	2	26	**3,5**
2.	8	3	5	1	17	**9**
3.	3	1	10	5	19	**7**
4.	7	9	7	3	26	**3,5**
5.	9	4	2	6	21	**6**
6.	5	2	3	8	18	**8**
7.	6	7	6	9	28	**1,5**
8.	2	6	8	7	25	**5**
9.	4	5	1	4	14	**10**
10.	1	8	9	10	28	**1,5**

3.2 Weighted order sum method (WSM)

Weighted order sum method appears to be the simplest method of multivariate comparisons considering the four methods [7]. It lies in the fact that the objects are ordered by each considered indicators. To the objects for which the indicator achieves the best value (the highest at maximization or the lowest at minimization), we assign a rank equal to the number of monitored objects (*n*) and object with the worst value of the order parameter (*1*).

If the same value of objects in one parameter occurs, we assign them the same rank, determined as the average of their respective order [8], [9], [10], [11].

We obtain indicator d_i by which the values are sequenced, as the sum of the order of individual parameters (p_{ij}) multiplied by the weight calculated parameters w_j:

$$d_i = \sum_{j=1}^{m} p_{ij}.w_j \qquad (1)$$

$i=1,2,...., n \quad j=1,2,....m \ \ (n=10, m=4)$

The object with the highest level of the indicator (d_i) is in the first place in the final order, the object with the second highest value is the second and so on (Table 4).

3.2.1 The determination of the parameter weights

The first step prior to the application of these methods is to determine the weights of indicators. We used the weights using the coefficients of variation from the relation:

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$$w_j = \frac{V_j}{\sum_{j=1}^{m} V_j} \quad , \quad \sum_{j=1}^{m} w_j = 1 \qquad (2)$$

$$V_j = \frac{s_j}{\bar{x}_j} = \frac{\sqrt{\frac{1}{n}\sum_{i=1}^{n}\left(x_{ij} - \bar{x}_j\right)^2}}{\bar{x}_j} \qquad (3)$$

- w_j are the weights for the *j- th* indicator,
- m is the number of indicators,
- V_j is the coefficient of variation of the *j- th* indicator,
- s_j is the standard deviation of the *j- th* indicator,
- $\bar{x}_j$ is the average value of the *j- th* indicator.

$$w_1 = \frac{0{,}2135}{0{,}2135 + 0{,}1723 + 0{,}3867 + 0{,}3703} = 0{,}1868$$

$$w_2 = \frac{0{,}1723}{0{,}2135 + 0{,}1723 + 0{,}3867 + 0{,}3703} = 0{,}1507$$

$$w_3 = \frac{0{,}3867}{0{,}2135 + 0{,}1723 + 0{,}3867 + 0{,}3703} = 0{,}3384$$

$$w_4 = \frac{0{,}3703}{0{,}2135 + 0{,}1723 + 0{,}3867 + 0{,}3703} = 0{,}3240$$

$$d_1 = 10.0{,}1868 + 10.0{,}1507 + 4.0{,}3384 + 2.0{,}3240 = 5{,}3766 \approx 5{,}38$$

Table 4 Weighted order sum method

Object	Weights				d_i	order
	ROS	ROE	CT	TL		
	0,1868	0,1507	0,3384	0,3240		
1.	1,87	1,51	1,35	0,65	5,38	**6**
2.	1,49	0,45	1,69	0,32	3,96	**9**
3.	0,56	0,15	3,38	1,62	5,72	**5**
4.	1,31	1,36	2,37	0,97	6,01	**4**
5.	1,68	0,60	0,68	1,94	4,91	**7**
6.	0,93	0,30	1,02	2,59	4,84	**8**
7.	1,12	1,06	2,03	2,92	7,12	**2**
8.	0,37	0,90	2,71	2,27	6,25	**3**
9.	0,75	0,75	0,34	1,30	3,14	**10**
10.	0,19	1,21	3,05	3,24	7,68	**1**

3.3 Points methods (PM)

When points method assign the object which reached the best indicator value of 100 points and other objects are assigned points as follows:

- while maximizing indicator:

$$b_{ij} = \frac{x_{ij}}{x_{\max}}.100 \qquad (4)$$

- while minimizing indicator:

$$b_{ij} = \frac{x_{\min}}{x_{ij}}.100 \qquad (5)$$

- x_{ij} is the value of the *j- th* indicator of the *i- th* object
- $x_{\max}$ is the maximum value of the *j- th* indicator of the *i- th* object valuation 100 points
- $x_{\min}$ is the minimum value of the *j- th* indicator of the *i- th* object valuation 100 points
- b_{ij} is the is scored of the *i- th* object for the *j- th* indicator

The resulting sequence is obtained by the weighted arithmetic average of the scores for individual variables. The best is the object for which the integral indicator (d_i) maximum. Point method takes the bit size differences in the monitored indicators (Table 5).

Table 5 Points Methods

Object	ROS	ROE	CT	TL	d_i	order
1.	100	100	54,84	34,18	72,26	**4**
2.	95,06	74,32	56,45	30,59	64,11	**8**
3.	63,58	51,48	100	53,60	67,16	**7**
4.	83,33	91,26	82,26	41,61	74,62	**3**
5.	96,30	75,85	27,42	54,47	63,51	**9**
6.	79,01	61,42	46,77	87,01	68,56	**5**
7.	81,48	86,23	74,19	89,33	82,81	**1**
8.	54,94	78,14	83,87	55,83	68,20	**6**
9.	64,81	76,17	24,19	42,95	52,03	**10**
10.	52,47	87,43	88,71	100	82,15	**2**

$$b_{21} = \frac{0{,}154}{0{,}162}.100 = 95{,}06$$

$$b_{14} = \frac{0{,}67}{0{,}96}.100 = 34{,}18$$

3.4 Standardized variable method (SVM)

When applying the standardized method we transpose the values of individual parameters to the standardized form as follows:

- while maximizing the indicator:

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$$n_{ij} = \frac{x_{ij} - \bar{x}_j}{s_j} \quad (6)$$

- while minimizing the indicator:

$$n_{ij} = \frac{\bar{x}_j - x_{ij}}{s_j} \quad (7)$$

– x_{ij} is the value of the *j- th* indicator of the *i- th* object
– $\bar{x}_j$ is the average value of the *j- th* indicator
– s_j is the standard deviation of the *j- th* indicator,
– n_{ij} is thes standard value of the *i- th* object for the *j- th* indicator

The resulting sequence is obtained by the weighted arithmetic average of the scores for individual variables. The best is the object for which the integral indicator (d_i) maximum. The method of standardized variables takes the variability of indicators into account (Table 6).

Table 6 Standardized variable method

Object	ROS	ROE	CT	TL	d_i	order
1.	1,3895	1,6179	-0,3658	-1,3124	0,3323	**4**
2.	1,0899	-0,2927	-0,3005	-1,7834	-0,3217	**9**
3.	-0,8202	-1,9919	1,4631	0,1413	-0,3019	**8**
4.	0,3783	0,9675	0,7446	-0,5958	0,3736	**3**
5.	1,1648	-0,1789	-1,4762	0,1822	-0,0770	**6**
6.	0,1161	-1,2520	-0,6924	1,1241	-0,1761	**7**
7.	0,2659	0,5935	0,4180	1,1650	0,6106	**1**
8.	-1,3446	-0,0081	0,8099	0,2437	-0,0748	**5**
9.	-0,7453	-0,1545	-1,6068	-0,4934	-0,7500	**10**
10.	-1,4944	0,6829	1,0059	1,3288	0,3808	**2**

$$n_{11} = \frac{0{,}162 - 0{,}1249}{0{,}0267} = 1{,}3895$$

$$n_{14} = \frac{1{,}3190 - 1{,}96}{0{,}4884} = -1{,}3124$$

4 Methods of order compliance

The compliance of the object order (companies, firms) as a result of the used methods can be assessed by means of the rank correlation coefficients: *Spearman's rank correlation coefficient, Kendall's coefficient of concordance.*

Table 7 quantified evaluation of ten objects, their order using four multi-criteria evaluation methods. All methods give approximately equal results.

Spearman's rank correlation coefficient measures the interrelation of two orders (x_i, y_i , - pairs are serial numbers):

$$r_s = 1 - \frac{6\sum_{i=1}^{n}(x_i - y_i)^2}{n.(n^2 - 1)}. \quad (8)$$

Table 7 . Order by methods

Object	Methods			
	SOM	WSM	PM	SVM
1.	3,5	6	4	4
2.	9	9	8	9
3.	7	5	7	8
4.	3,5	4	3	3
5.	6	7	9	6
6.	8	8	5	7
7.	1,5	2	1	1
8.	5	3	6	5
9.	10	10	10	10
10.	1,5	1	2	2

If we have equal values we use the *rectified version* of *Spearman's rank correlation coefficient*:

$$r_s = 1 - \frac{6\sum_{i=1}^{n}(x_i - y_i)^2}{n.(n^2 - 1) - c} \quad (9)$$

c is the correction factor, $c = \sum_{j=1}^{k}\left(c^3{}_j - c_j\right)$,

c_j - the number of times in the first or in the second file.

Kendall's coefficient of concordance generalizes *Spearman's rank correlation coefficient* for more than two-dimensional file (A_{ij} - sum of serial numbers that have been assigned to the *i-th* object):

$$r_K = \frac{12}{r^2\left(n^3 - n\right)}\sum_{i=1}^{n}A_i^2 - 3\frac{n+1}{n-1}. \quad (10)$$

For equally ranked objects:

$$r_K = \frac{12[\sum_{i=1}^{n}A_i^2 - \frac{r^2 n(n+1)^2}{4}]}{r\left[rn\left(n^2 - 1\right) - c\right]}. \quad (11)$$

Spearman's rank correlation coefficient and Kendall's coefficient of concordance reach values from the interval $\langle -1,1 \rangle$. If the orders are completely identical then $r_s = 1$, if they are completely opposite, then $r_s = -1$, if $r_s = 0$, then both orders are independent. Calculated coefficients indicate a high consistency of the methods used among objects of a given file (Table 8).

Table 8 Spearman's rank correlation coefficient

Object	$(x_i - y_i)^2$					
	SOM WSM	**SOM PM**	**SOM SVM**	**WSM PM**	**WSM SVM**	**PM SVM**
1.	6,25	0,25	0,25	4	4	0
2.	0	1	0	1	0	1
3.	4	0	1	4	9	1
4.	0,25	0,25	0,25	1	1	0
5.	1	9	0	4	1	9
6.	0	9	1	9	1	4
7.	0,25	0,25	0,25	1	1	0
8.	4	1	0	9	4	1
9.	0	0	0	0	0	0
10.	0,25	0,25	0,25	1	1	0
Σ	16	21	3	34	22	16
c	12	12	12			

Spearman's rank correlation coefficient

- SOM – WSM.: $r_s = 1 - \frac{6.16}{10.(10^2 - 1) - 12} = 0{,}9018$
- SOM – PM: $r_s = 1 - \frac{6.21}{10.(10^2 - 1) - 12} = 0{,}8712$
- SOM –SVM: $r_s = 1 - \frac{6.3}{10.(10^2 - 1) - 12} = 0{,}9816$
- WSM –PM: $r_s = 1 - \frac{6.34}{10.(10^2 - 1)} = 0{,}7939$
- WSM- SVM: $r_s = 1 - \frac{6.22}{10.(10^2 - 1)} = 0{,}8667$
- PM – SVM: $r_s = 1 - \frac{6.16}{10.(10^2 - 1)} = 0{,}9030$

Kendall's coefficient of concordance confirmed the high concordance in the ranking.

$$r_K = \frac{12\left(6044 - \frac{4^2 10(10+1)^2}{4}\right)}{4\left(4.10.(10^2 - 1) - 12\right)} = 0{,}9149 .$$

Conclusion

Selected financial indicators for the 10 companies were compared using the above methods. On the basis of these methods the order of the objects is compiled. The methods result in similar orders of the objects. Compliance was verified by serial order coefficients. The values of these coefficients indicate a high order compliance. Such a comparison will serve companies for the purpose of company development planning.

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