Application of synthetic measure to assess and model the financial condition of a company

Paweł Dziekański[15]

Abstract: Enterprises should regularly analyze the results of their operations, as well as their financial condition. The source material for the analysis of the financial condition are financial statements. They present a picture of the property and financial condition of the enterprise for a certain period of time. The purpose of the article is to examine the usefulness of a synthetic measure for assessing the financial condition of enterprises. The CRITIC-TOPSIS method was used in the analysis. The study of financial condition provides information for evaluating and correcting the activities carried out. The increase or decrease in synthetic measures must be considered as a way to assess the effects of the financial condition to date. The assessment of financial condition using subindices of evaluation, i.e. liquidity, debt, profitability, as well as the synthetic measure can indicate trends in the studied area, positions in the industry, the situation of the unit. The synthetic measure of financial condition can complement the traditional ratio analysis.

Introduction

Enterprises (as a combination of human, financial, physical and information resources) should systematically analyze and evaluate the performance of their business, including the financial result. They operate in a specific space and interact with the environment to achieve their goals. Under the conditions of a market economy and intensifying competition, companies should constantly analyze the results of their activities, acquiring relevant decision-making information [Kraska, 2022].

Well prepared information should be the basis for supporting current and developmental decisions. It is both a commodity and a resource used in the broader social and economic life, it is a factor of production [Łukasik-Makowska, Niedzielska, 2003]. Making the right decisions (including financial ones) is crucial to the functioning of the probability and achieving the goals set by the owners (i.e. maximizing profits and increasing their market value) [Szyszko, Szczepański, 2007]. The information that comes directly from the financial statements is intended to help manage the company. The analysis of the financial situation makes it possible to evaluate the past, present and future activities of the enterprise [Sierpińska, Jachna, 1999].

Financial condition is the financial state of an economic entity over a certain period of time. It represents solvency, as well as the ability to generate profits and expand property and capital resources [Kowalak, 2003]. t is also a state of profitability for companies and is a result of the economic activities they undertake [Bartnicki, 2016]. The financial condition is important for company managers.

The source material for the analysis of the financial position are financial statements. Based on Polish accounting regulations, they consist of: balance sheet, profit and loss account and notes, cash flow statement, statement of changes in equity [Sierpińska, Jachna, 2007]. Based on them, business activities can be analyzed. They also form the basis for planning, as well as foster the evaluation and control of current activities. They present a synthetic picture of the property and financial situation of the enterprise for a certain period of time or for a given period of time [Gabrusewicz, 1995, Rybicki, 2003].

The aim of the article is to examine the usefulness of the synthetic measure for assessing the financial condition of enterprises. The analysis uses the CRITIC-TOPSIS method, which allows aggregation of characteristics and linear ordering of enterprises according to the synthetic characteristic.

Literature review

The evaluation of a company's financial position is used as an instrument to support management, as well as an element of management accounting or controlling. In its evaluation, financial statement analysis, ratio analysis and analysis using discriminant models are used [Kowalak, 2011].

The financial condition is both the goal of the company's operations and the result of previously made decisions. E. Siemińska defines financial condition as the financial position of an enterprise as a result of the decisions made and the associated development opportunities [Siemińska, 2002]. T. Dudycz and S. Wrzosek define the financial condition of an enterprise as an assessment of the state of its finances and the financial efficiency of its economy [Dudycz, Wrzosek, 2000]. L. Bednarski and T. Waśniewski define the financial condition of an enterprise as the results achieved, the state of resources and the development prospects based on tchem (Bednarski, Waśniewski ([ed.), 1996]. Financial condition is a complex phenomenon that is influenced by many factors. Knowledge of it allows comparisons to be made with other companies, and is also helpful in making financial decisions.

The assessment of the financial position is a complex phenomenon and its quality depends to a large extent on the properly selected method of analysis. The synthetic measure method makes it possible to determine the state of the entity's financial condition for a certain period of time and show

[15] Department of Economics and Finance, Faculty of Law and Social Sciences, Jan Kochanowski University.

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its position in comparison with other entities belonging to the same sector [Witkowska, Witkowski, 2011]. It also allows you to perform;

analysis over time (involves comparing measures with historical values, which allows you to observe the prevailing trend with regard to the financial situation),

analysis in space (comparing the measures of the company under study with competitors in the industry, which allows you to indicate the position of the entity in the market), and

analysis with regard to benchmark values [Sierpińska, Jachna, 2006].

Performance ratios, liquidity ratios, debt ratios, profitability ratios can be used to build a synthetic measure of financial conditio [Szyszko, Szczepański, 2003]. It is also possible to build a synthetic measure within one of the mentioned groups of indicators.

Analysis of the financial condition makes it possible to assess economic efficiency, financial position, identify strengths and weaknesses, as well as opportunities and threats, appropriately shape the asset-capital structure and cash flow, control costs and financial result [Nesterowicz, 2016]. Owners want to know the financial health of the company in order to assess the effectiveness of the capital employed. Management bodies want to know the condition of companies in order to influence capital allocation. Government bodies in order to shape government tax policy. Potential investors gather information about the financial condition for the purpose of assessing the risks incurred in investing capital in a particular enterprise [Nowak, 1997].

Factors affecting a company's financial position can be micro and macroeconomic, quantitative and qualitative, internal and external. These include: value of fixed and current assets, the ability of assets to generate profit, structure of assets and liabilities, liquidity, financial profitability, value of sales revenue [Jerzemowska (red.), 2006, Siemińska, 2002, Bombiak, 2010].

Material and method

In the process of creating a synthetic measure of a company's financial health, the CRITIC-TOPSIS method was used. The value of the synthetic measure was determined in the following steps:

The selection of diagnostic variables (Table 1) and the determination of the direction of their preference in relation to financial condition. They are related to each other and form a multidimensional space, occurring in the same spatial and spatial perspective.

Table 1 Diagnistic variables describing the financial condition of the company

Current liquidity ratio	total current assets / current liabilities
Quick liquidity ratio	total current assets - inventories - accruals / shortterm liabilities
Return on assets ROA	net profit / total assets
Return on equity ROE	net profit / equity
Return on sales ROS	net profit / sales revenue
Liquidity turnover cycle in days	(shortterm receivables / net sales revenues) x number of days in the period
Inventory turnover cycle in days	(inventories / net sales revenues) x number of days in the period
Payables turnover cycle in days	(liabilities / net sales revenues) x number of days in the period
Cash conversion cycle in days	inventory turnover cycle in days + receivables turnover cycle in days - payables turnover cycle in days

Source: own study (selected set of indicators by the author, as an example of analysis) [Jachna, Sierpińska, 2004].

The collected set of diagnostic variables was subjected to selection for the coefficient of variation and the level of correlation. It was presented, as a matrix X_{ij}:

$$X_{ij} = \begin{bmatrix} x_{11} & x_{12} & \dots & x_{1m} \\ x_{21} & x_{22} & \dots & x_{2m} \\ \dots & \dots & \dots & \dots \\ x_{n1} & x_{n2} & \dots & x_{nm} \end{bmatrix} \quad (1),$$

where: X_{ij} – denotes the values of the j-th variable for the i-th object, i - object number (i = 1, 2, ..., n), j – variable number (j = 1, 2, ..., m).

Unitarization of the values of diagnostic variables, according to the formula:

$$X_j \in S, Z_{ij} = \frac{x_{ij} - \min_i x_{ij}}{\max_i x_{ij} - \min_i x_{ij}},\ Z_{ij} = 0 \Leftrightarrow x_{ij} = \min_i x_{ij};\ Z_{ij} = 1$$

$$\Leftrightarrow x_{ij} = \max_i x_{ij}, \quad (2).$$

$$X_j \in D, Z_{ij} = \frac{\max_i x_{ij} - x_{ij}}{\max_i x_{ij} - \min_i x_{ij}},\ Z_{ij} = 0 \Leftrightarrow x_{ij} = \max_i x_{ij};\ Z_{ij} = 1$$

$$\Leftrightarrow x_{ij} = \min_i x_{ij}, \quad (3).$$

where: S-stimulant, D-destimulant, i=1, 2...n (number of variables selected for analysis); j=1, 2...m (number of instances of the value of a variable), $\max_{xij}$ - the maximum value of the j-th variable, $\min_{xij}$ - the minimum value of the j-th variable, x_{ij} – denotes the value of the j-th variable for it object, Z_{ij} normalized value of jth variable for itego object, the value belongs to the interval [0;1] [Kukuła, 1999]. As a result of the process of zero-based unitization of the output diagnostic variables, we obtain a matrix of values Z_{ij}:

$$Z_{ij} = \begin{bmatrix} z_{11} & z_{12} & \dots & z_{1m} \\ z_{21} & z_{22} & \dots & z_{2m} \\ \dots & \dots & \dots & \dots \\ z_{n1} & z_{n2} & \dots & z_{nm} \end{bmatrix}, \quad (4)$$

where: $Z_{ij} \in \{S\} \cup \{D\}$ - zunitarized value of the j-th variable for the i-th object; i=1, ..., m, j=1, ..., k, are the normalized values of the jth diagnistic variable for it object.

Weights for selected variables were determined using the TOPSIS-CRITIC (Criteria Importance Through Intercriteria Correlation) method. The weights in the method are determined based on standard deviations and correlations

between variables [Polcyn, 2022]. They were determined using the formulas:

$$w_j = \frac{C_j}{\sum_{k=1}^{K} C_k}, j = 1,2,\dots,K, (5),$$

$$C_j = S_{j(Z)} \sum_{k=1} (1 - r_{jk}), j = 1,2,\dots K, (6),$$

where: C_j denotes a measure of the information capacity of the jth variable, $S_{j(Z)}$ is the sandard deviation oblicated from the normalized values of jth variable, r_{jk} correlation coefficient between trait jta and kta. The sum of the coefficients is 1. C_k is the sum of the information measure of all criteria.

A larger value of Cj indicates that more information can be obtained from the given criterion. The normalized values of the diagnostic variables are multiplied by the weighting factor w_j ($Z^*_{ij} = Z_{ij} * w_j$) [Rostamzadeh, et all, 2018, Slebi-Acevedo, et all, 2019].

In the next step, we determine the Euclidean distances of each object from the pattern (=1) and the anti-pattern (=0) [Wysocki, 2008]. Determination of the value of the synthetic measure. It allows a multifaceted and comprehensive view of the level of financial conditio (Hwang, Yoon, 1981). The value of the synthetic measure was determined using the TOPSIS (Technique for Order Preference by Similarity to an Ideal Solution) method based on the formula [Özkan, at all, 2021, Kozera, at all, 2021]:

$$q_i = \frac{d_i^-}{d_i^- + d_i^+}, \text{where } 0 \le q_i \le 1, i = 1,2,\dots,n; (7)$$

where: $q_i \in [0;1]$; d_i^- - means the distance of the object from the anti-pattern (from 0), d_i^+ denotes the distance of the object from the pattern (from 1) (Behzadian, at all, 2012).

Linear ordering and classification of analyzed enterprises in terms of financial condition. Classification was made based on the arithmetic average ($\overline{q}$) and standard deviation (S_q) from the value of the synthetic measure. The following groups were identified:

Gr I. (top level) $\overline{q} + S_q \le q_i$

Gr II. (high level) $\overline{q} \le q_i < \overline{q} + S_q$

Gr III. (average level) $\overline{q} - S_q \le q_i < \overline{q}$

Gr IV. (low level) $q_i < \overline{q} - S_q$ (10),

Pearson's linear correlation coefficients, Speramn's rank, gamma and Kendall's tau coefficients were used to analyze and evaluate the strength of the relationship between the variables and the synthetic measure of the study areas (Dziekański, Prus, Maitah, Wrońska, 2021, Drozdowski, Dziekański, 2022). The scatter and bag charts presented in the aspect of the synthetic measure made it possible to show the differentiation of the subsamples and to indicate outliers (calculations and charts were made in Ststistica software). The Gini index is a measure of the concentration (unevenness) of the distribution of the variable under study. It takes a value between 0 and 1 (the concentration index was calculated in the Ststistica program) (Krukowska, 1981).

Results

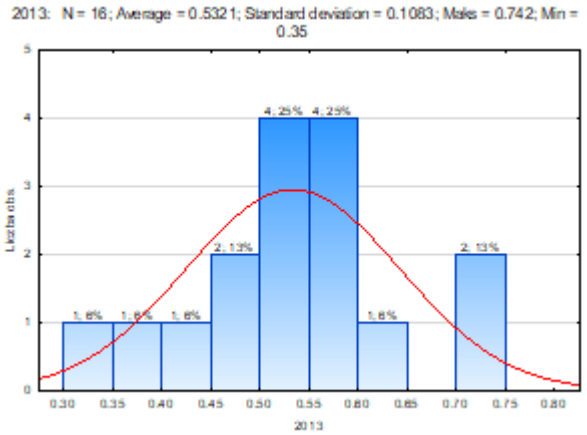
The financial condition of an enterprise presents the state of its financial management. The synthetic measure of financial condition ranged from 0.350 to 0.742in 2013 and from 0.361 to 0.742 in 2023. An increase in the value of the measure may indicate a change in the situation of the studied unit compared to all facilities. The measure of central tendency (mean) takes on higher values in the 2013/2023 relationship. In the case of measures of variability, we can observe both a decrease (striatum, standard deviation), an increase (coefficient of variation). A decrease in kurtosis values indicates a greater spread of values, poor concentration, flattening of the abundance curve. We observe rightward skewness (skewness >0). Rightward skewness indicates that a smaller number of units have values of variables smaller than their mean value. The greater the skewness, the greater the asymmetry of the distribution.

Table 2. Characteristics of the descriptive statistics of the synthetic measure of financial condition

	2013	2023
Average	0.532	0.543
Minimum	0.350	0.361
Maximum	0.742	0.742
Range	0.392	0.381
Quartile. (Range)	0.083	0.087
Standard deviation	0.108	0.107
Coefficient of variation	20.358	19.643
Skewness	0.187	0.089
Kurtosis	0.104	-0.125

Source: own study.

Figure 1 shows the number of observations and the distribution model of the synthetic measure of financial health in 2013 and 2023. The most numerous range for the measure in 2013 is 0.50-0.55; 0.55-0.60 (4, 25%) and 0.55-0.60 (5, 31%) in 2023.



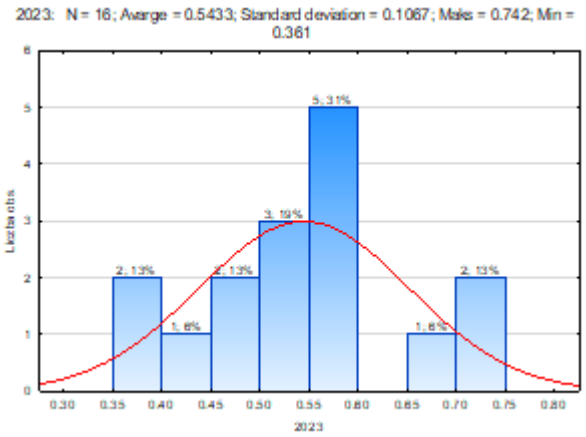


Figure 1: Distribution of the synthetic measure of financial health in 2013 and 2023.
Source: own study.

The spatial variation of companies within the framework of financial health is presented in

Figure 2. It also indicates outliers.

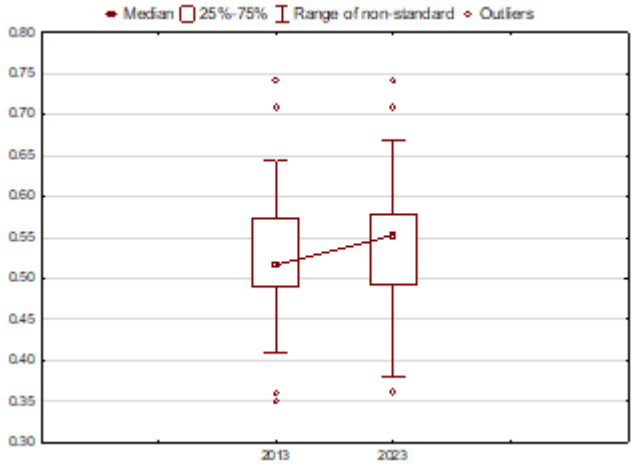


Figure 2: Variation of the synthetic measure of a company's financial condition in 2013 and 2023.
Source: own study

The position of companies within the groups has changed slightly. They moved to the higher value group, as well as to the lower value groups of financial condition. Larger changes in the number of units are observed in groups 3 and 4. Enterprises of group 1, are characterized by a better level of diagnostic variables in relation to group 3 (Table 3).

Table 3. Categorization of diagnostic variables by financial condition measure groups

	2013				2023			
Group	1	2	3	4	1	2	3	4
Number of units	3	4	6	3	3	5	5	3
Current liquidity ratio	1.64	1.69	1.71	1.38	1.64	1.70	1.69	1.38
Quick liquidity ratio	0.97	0.97	0.86	0.83	0.97	0.88	0.92	0.83
Return on assets ROA	13.35	10.25	8.27	7.2	14.35	10.24	7.89	7.20
Return on equity ROE	22.08	14.21	14.28	10.4	24.08	14.97	13.54	10.40
Return on sales ROS	3.92	2.86	1.85	1.4	4.92	2.73	1.78	1.40
Liquidity turnover cycle in days	14.13	12.83	11.42	10.93	14.13	12.80	11.16	10.93
Inventory turnover cycle in days	137.67	135.4	133.83	124.8	137.67	130.52	138.40	124.80
Payables turnover cycle in days	59.73	57.75	57.57	56.07	59.73	59.60	55.68	56.07
Cash conversion cycle in days	90	84.2	89.12	81.63	90.00	85.56	88.74	81.63
Synthetic measure	**0.70**	**0.57**	**0.5**	**0.37**	**0.71**	**0.57**	**0.51**	**0.38**

Source: own study

Table 4 presents the Pearson correlation coefficient (positive and negative) between the values of the synthetic measure and the values of the diagnostic variables in 2020. It also indicates the significant impact of ROA, ROE and ROE on the financial condition of enterprises.

Table 4 Correlation of synthetic measure - financial condition and diagnostic variables

Variable	Pearson		Rang Sperman		Gamma		kendall's tau	
	2013	2023	2013	2023	2013	2023	2013	2023
Current liquidity ratio	0.408	-0.088	0.296	0.389	0.252	0.308	0.238	0.291
Quick liquidity ratio	0.362	0.020	0.490	0.261	0.365	0.192	0.340	0.179
Return on assets ROA	0.697	0.642	0.650	0.693	0.537	0.574	0.509	0.545
Return on equity ROE	0.698	0.661	0.575	0.529	0.477	0.405	0.459	0.390
Return on sales ROS	0.630	0.165	0.768	0.828	0.628	0.717	0.610	0.696
Liquidity turnover cycle in days	0.517	-0.064	0.512	0.547	0.449	0.449	0.406	0.406
Inventory turnover cycle in days	0.428	-0.127	0.442	0.458	0.340	0.380	0.310	0.347
Payables turnover cycle in days	0.202	0.129	0.318	0.393	0.245	0.286	0.221	0.258
Cash conversion cycle in days	0.334	0.126	0.158	0.296	0.137	0.235	0.127	0.217

Marked correlation coefficients are significant with p < .05000

Source: own study

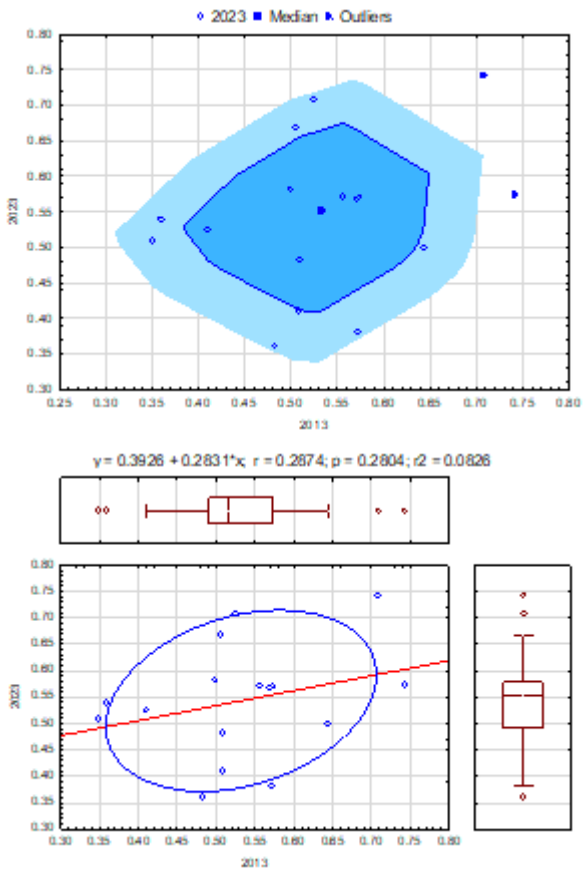


Figure 3: Scatter and bag chart of the synthetic measure - financial condition in relation 2013/2023.
Source: own study.

In the case of the relationship of the synthetic measure of financial condition 2013/2023, as presented in Figure 3 we observe a low correlation coefficient (0.287). The bag chart indicates groups of companies that are statistically similar (including outliers, whose graphical shape in subsequent years indicates their differentiation).

Spatial differentiation of the financial condition of enterprises is influenced by demographic potential, quality of life, infrastructure. The differentiation is due to natural and historical conditions, as well as natural processes of social and economic development, access to investment capital, access to knowledge. A measure of the concentration of the phenomenon - the Gini coefficient takes on the values of 0.234 (in 2013) and 0.231 (in 2023). The higher the value of the index, the greater the degree of concentration of the synthetic measure, and the greater its variation.

Conclusions

The assessment of financial condition using sub-indices of evaluation, i.e. liquidity, debt, profitability, as well as the synthetic measure can indicate trends in the area under study, positions in the industry, the situation of the entity in the year-on-year analysis. The synthetic measure of financial condition can complement the traditional ratio analysis. It allows comparisons of enterprises among themselves, or making decisions on the future.

A systematic study of financial condition should provide information for the evaluation and correction of ongoing activities. The increase or decrease in synthetic measures must be considered as a way to assess the effects of the financial condition to date. The results obtained can be an important source of information for the enterprise (and its environment) about the disparities that exist between units.

The results obtained point to directions for new research, i.e. comparing the results of ordering on the basis of a larger number of variables, carrying out analysis in dynamic terms over a certain increased period of time in order to learn about the trend of change, analyzing outliers and determining their impact on the situation of the studied area.

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