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THE APPLICATION OF THE MULTIVARIATE COMPARATIVE ANALYSIS TO A COMPANY'S FINANCIAL PERFORMANCE EVALUATION AND BENCHMARK FORECASTING

Summary: A company's financial performance is a complex phenomenon. At least several different financial ratios are required to describe it thoroughly. In this paper problems associated with a company's financial performance evaluation and forecasting have been discussed in comparison to other companies in the same industry. The multivariate comparative analysis and the Monte Carlo simulation methods have been employed in this study. As far as creating a company ranking is concerned, a procedure based on the distribution function of the synthetic financial performance ratio has been applied.

Key words: synthetic financial performance ratio, financial performance forecasting, company ranking.

1. Introduction

To evaluate a company's financial performance the wide range of financial ratios that determine its individual aspects, i.e. liquidity, activity, debt, profitability, is applied. Much as an analysis of a company's financial condition based on financial ratios should finish with a clear-cut conclusion, such a task often presents a lot of problems even to the most experienced financial analysts in this field. In most cases the major difficulty lies in the fact that an evaluation carried out on the basis of different financial ratios lacks coherence – while some ratios seem to imply an improvement in the company's financial performance, other indicate the opposite, and still there are some ratios that have not changed in any significant way which may suggest that the company has remained in its pre-existing either good or bad shape.

Over the past few centuries, synthetic methods for evaluating a company's financial performance have been developed in economics and other theories dealing with a company's finances. Economic profit, for example, constitutes one of such basic measures. Expressed in absolute values, however, economic profit fails to determine the effectiveness of a company's performance, which is widely believed to be the most important characteristics of every enterprise. In both theory and practice, it is economic effectiveness ratios that are considered as the most handy tool for carrying out a synthetic evaluation of a company's financial performance.

Today, two different approaches towards the question of a financial performance evaluation can be distinguished; the first one thrives on traditional measurement strategies, such as ROE (Return on Equity), ROA (Return on Assets), or ROS (Return on Sales), whereas the other is based on modern ones, such as EVA (Economic Value Added) or CFROI (Cash Flow Return on Investment) [Nita 2007]. Traditional measurement strategies are broadly believed to have a number of flaws (see for instance [Dudycz 2005, p. 152-154], including the fact that an evaluation employing such strategies fails to recognize all aspects of financial performance. This refers to financial liquidity in particular. On the other hand, creating and applying modern measurement strategies that would allow for this particular aspect at a theoretical level requires a great deal of accounting data proofreading, and as a result access to the most detailed financial data. Moreover, with the EVA measurement strategy taken here as an example, it is hardly possible to make any corrections at all, as EVA authors have patented the way it is calculated.

Bearing in mind all that has been discussed above, one might be tempted to formulate the following question: is it possible to carry out a synthetic evaluation of a financial performance in such a way as to allow for all its aspects, with an analysis based on widely available financial data? This problem has been the focus of attention of many scientists, who would usually apply the multivariate comparative analysis to come up with a solution (see for instance [Pluta 1975; Szpulak 2002; Appenzeller 2008]. The thesis proposed in this paper says that applying multivariate comparative analysis methods would make it possible to create a measurement strategy (the so-called synthetic financial performance ratio) that would constitute a function of those financial ratios which describe individual aspects of a financial performance and are calculated on the basis of data included in financial statements.

Theoretically simple as it is, the construction of the synthetic variable becomes a serious challenge if it is going to be used in the process of creating the synthetic financial performance ratio; solutions offered in literature dealing with the question of financial ratio normalization have not yet been adjusted to serve this purpose. The list of major problems in this area usually includes the following: no explicit definition for the nature of variables – financial ratios (i.e., ”stymulanta", "destymulanta", ”nominanta"), additional variables with so called veta thresholds, the lack of norms for financial ratios and/or variable values at the veta threshold, the questionable structure of the standard based on extreme values (particularly with respect to a strongly asymmetric and unstable distribution of financial ratios), the lack of an unambiguous interpretation of results, particularly with respect to spatial comparisons, and, finally, divergent opinions on the question of financial ratio selection criteria.

This paper attempts to find a solution to one of the problems listed above. The main objective set by the authors is to generate the synthetic ratio of a company's financial performance that would help to create a classification of all companies operating in the same industry based on their financial health status. Normalization and standardization procedures have been discussed briefly in this paper, as well as the procedure for creating the synthetic variable. Furthermore, a simulation procedure has been employed to generate the distribution function of the synthetic financial performance ratio. In the practical part of this paper an evaluation and forecast of the *ZPC Mieszko S.A.* company's financial performance have been presented, as well as a ranking of companies operating in the candy industry in Poland. For the sake of the empirical study, data coming from annual financial statements available at Emerging Markets and Notoria Service databases has been used.

2. Literature review

The multivariate comparative analysis constitutes one of the multivariate data analysis methods which include, inter alia, the following: aggregate analysis, discriminatory analysis, factor and major constituent analysis, multidimensional scaling, as well as multivariate regression analysis and data mining techniques. The common feature of all multivariate data analysis methods is that they can all be employed in a single study with a view to find a solution to a specific research problem, which in most cases is [Grabiński 1989, p. 86-87]:

(1) in exploratory studies:

- multi-attribute object classification,
- hierarchization of objects and sets of objects,

(2) in explanatory studies:

- selection of the best diagnostic attributes on the basis of which objects can be assigned to a given set or position,
- analysis of the significance and nature of correlation between different diagnostic attributes, and between diagnostic attributes and the synthetic variable,
- determination of development standards, development paths and development isoquants.

The multivariate comparative analysis consists mainly of normalization and aggregation methods and techniques in which a single variable, the so-called synthetic variable, is employed to provide a description of various complex phenomena, such as social and economic growth, the standard of living, or a financial performance. However, it needs to be stated at this point that the synthetic variable can be generated with the use of different and more statistically advanced methods of the multivariate data analysis, such as the multivariate regression analysis, major constituent analysis, or discriminatory analysis. Compared to those, the multivariate comparative analysis appears basically as a transparent and simple method; these are arguably its chief assets. All in all, the multivariate comparative analysis has not enjoyed much popularity in the West. It has virtually remained unknown there and has not been almost at all used, of which the most indicative fact, amongst other things, is that it has been included neither in STATISTICA nor SAS, the most popular packages used for carrying out statistical data analyses.

Multivariate comparative analysis methods were developed in the 1970's, with Polish and Wrocław's scientists contributing to this achievement to a significant extent. There can be little doubt that the pioneer work in this field was delivered by Prof. Z. Hellwig in 1968. In it [Hellwig 1968] he presented a method for creating an aggregate development measure. The work of Prof. Z. Hellwig was continued by a lot of his students, for instance Prof. M. Cieślak, T. Borys and W. Pluta. M. Cieślak introduced an alternative method for variable standardization, consisting in a quotient of a variable value and its standard deviation [Cieślak 1974]. T. Borys defined the criteria for normalized variables, i.e. additivity, range stability, preference uniformity and positivity, and introduced the concept of 'nominata' to the analysis [Borys 1978]. W. Pluta was the first scientist ever to have applied multivariate comparative analysis methods to a company's economic performance evaluation [Pluta 1975]. Other scientists working in this field who need to be mentioned here are, inter alia, [Wydymus 1984], [Grabiński 1984] and [Strahl 1996].

3. Financial ratio normalization

Depending on their influence on financial performance, financial ratios can be divided into the following categories: stymulantas, destymulantas and nominantas. Stymulantas are those ratios whose increased values translate into financial performance improvement. Destymulantas are the exact opposite, as they are expected to display a decrease in their values. Finally, nominantas can be characterized by a certain optimum (nominal) level, from which any deviation directed upward or downward can be interpreted as having a negative impact on company's financial situation.

The main objective of normalization is to facilitate the mutual comparability of different ratios. Ratios are often expressed in different units of measure which prevents their direct aggregation (e.g. zł, zł/unit, day; some ratios lack any units of measure at all). The normalization process removes units of measure from ratios. It also allows us to transform destymulantas and nominantas into stymulantas, and equalize ranges of individual financial ratios.

A series of normalization procedures can be expressed via a general formula presented below [Grabiński 1988, p. 244]:

$$x'_i = \left(k\frac{x_i - a}{b}\right)^p, \tag{1}$$

where: x'_i – is the normalized value of the X_i ratio,

x_i – is the value of the X_i ratio,

a – is the subtrahend taking the following values: 0, $x_{\min}$, $\overline{x}$,

b – is the divisor taking the following values: $x_{\max}$, $x_{\min}$, $x_{\mathrm{nom,D}}$, $x_{\mathrm{nom,G}}$, x_{wz}, $\overline{x}$, s, $\sum x_i$, R, PC_l,

$x_{\max}$ – is the maximum value of the X_i ratio,
$x_{\min}$ – is the minimum value of the X_i ratio,
$\overline{x}$ – is the average value of the X_i ratio.

$$\overline{x} = \frac{1}{n}\sum_{i=1}^{n} x_i, \tag{2}$$

$x_{nom,D}$ – is the bottom value of the X_i ratio nominal range,
$x_{nom,G}$ – is the top value of the X_i ratio nominal range,
x_{wz} – is the standard value of the X_i ratio,
s – is the standard deviation:

$$s = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(x_i - \overline{x})^2}, \tag{3}$$

R – is the range:

$$R = x_{\max} - x_{\min}, \tag{4}$$

PC_l – is the value of the l – th percentile of the X_i variable, the number of the l percentile is usually equal to: $l = 5$, $l = 10$, $l = 25$ for destymulantas, and $l = 75$, $l = 90$, $l = 95$ for stymulantas, values $x_{i,t}$ that exceed (with respect to stymulantas) or are lower than (with respect to destymulantas) specified percentiles take the $x'_{i,t} = 1$ value once normalized.
k – is the multiplier taking the following values: $k = -1$, $k = 1$,
p – is the exponent usually taking the following values: $p = -1$; $p = 0.5$; $p = 1$; $p = 2$.

The most popular normalization procedure is the standardization expressed by the following formula:

$$x'_i = \frac{x_i - \overline{x}}{s}, \tag{5}$$

The standardization process removes a variable's unit of measure. A standardized variable has a zero-mean and a unitary variance. As the result of T. Grabiński's studies on the standardization process this became one of the most effective normalization methods due to *a high degree of correlation between the synthetic variable and prime variables and (...) a small taxonomic distance between the synthetic variable and prime variables* [Grabiński 1989, p. 133], which implies that in the standardization process the variability of the synthetic variable can be replaced by the variability of prime variables without any major distortion taking place.

The following conditions need to be met if the synthetic variable is to be created on the basis of standardized variables:

1. All variables need to be stymulantas. If they are not, they have to be transformed prior to their standardization. Out of many existing transformation formulas (for instance [Grabiński 1989, p. 28; Walesiak 2006, p. 18; Kolenda 2006, p. 22]), we would like to recommend the following ones:

(a) for destymulantas:

$$x_i^s = -x_i \tag{6}$$

(b) for nominantas:

$$x_i^s = \begin{cases} 0, & \text{dla } x_{nom,D} \le x_i \le x_{nom,G} \\ x_{nom,G} - x_i, & \text{dla } \quad x_i > x_{nom,G} \\ x_i - x_{nom,D}, & \text{dla } \quad x_i < x_{nom,D} \end{cases}, \tag{7}$$

2. Variables cannot have any additional veta thresholds. How to handle variables with veta thresholds has been described by Strahl and Walesiak [1997].

4. The structure of the synthetic financial performance measurement model

In this case, the essential part of the structure of the synthetic financial performance measurement model, i.e. an evaluation of a company's performance carried out in comparison with other companies in the same industry, can be argued to consist in transforming the multivariate matrix of financial ratios *X* into a single-variate series of values of the synthetic financial performance measurement model *X'*:

$$\begin{bmatrix} x_{1,1} & \cdots & x_{n,1} \\ \vdots & \vdots & \vdots \\ x_{1,n} & \cdots & x_{n,m} \end{bmatrix} \rightarrow \left[x_1^{'}, \ldots, x_n^{'} \right] \tag{8}$$

The multivariate matrix of financial ratios is composed by *m* financial ratios characterizing *n* companies.

While creating such a synthetic ratio, it is important to assign an adequate weight to individual financial ratios. The weight represents a relative significance of a given ratio as a component of a company's financial performance evaluation. This problem, however, is still to be solved in a satisfying way. It has been argued the process of attaching an adequate weight to a given ratio should be consulted with experts in the field. Applying the variance of variables is just another solution [Grabiński 1988, p. 243]:

$$w_j = \frac{V_j}{\sum_{j=1}^{m} V_j}, \tag{9}$$

where: w_j – is the weight attached to the *j*-th variable,

V_j – is the variability coefficient of the *j*-th variable, on the condition that:

$$V_j = \frac{s_j}{\bar{x}_j}. \tag{10}$$

A factual analysis of a phenomenon, however, can sometimes lead to a conclusion that the variable variance should be excluded from the process of weight calculation. Furthermore, it has been stated in the aforementioned T. Grabiński's study that "out of numerous weight systems scrutinized in this work the constant weight system appears to be the most adequate one" [Grabiński 1988, p. 133]. As a result, in most cases weights are not applied at all:

$$w_1 = w_2 = \ldots = w_m = \frac{1}{m}. \tag{11}$$

Once normalized values of financial ratios and a weight system are at our disposal, they can be aggregated. Another quotation from T. Grabiński seems justifiable at this point: "As far as the degree to which the synthetic variable is correlated with prime variables and their taxonomic distance are concerned, one of the best aggregation formulas available is the arithmetic mean formula" [Grabiński 1988, p. 133]. Having taken this statement into consideration, it becomes clear that the synthetic financial performance ratio employed in this study is nothing but an arithmetic mean of normalized financial ratio values:

$$\overline{x}' = \sum_{j=1}^{m} w_j x'_j. \tag{12}$$

Represented by formula (12), the synthetic financial performance ratio allows us to create a ranking of companies. The higher the synthetic ratio, the better the financial condition of a given company. Unfortunately, with the distribution function of the synthetic ratio being still beyond our grasp at this very point of the argument, there is no such analysis of synthetic ratio values calculated for individual companies that would enable us to interpret the results in any reasonable way. For instance, does a 1.8 synthetic ratio value indicate the fact that a company is doing well when compared to its competitors? Under certain circumstances such a value may turn out to be just a mediocre one. With a different distribution function, on the other hand, even a value of 0.1 may be indicative of a market leader in perfect financial health. Therefore the authors of this paper suggest an evaluation of a company's financial performance be carried out on the basis of the distribution function of the synthetic ratio instead of the synthetic ratio value itself.

5. Calculating the distribution function of the synthetic financial performance ratio

The main benefit of the application of the synthetic ratio distribution function is the fact that it becomes much easier now to interpret the results. Distribution function values belong to the interval (0.1). For a given synthetic ratio value a percentage of companies characterized by a financial performance worse than that of the analysed one can be calculated with the use of the synthetic ratio distribution function.

Quite often calculating the distribution function of the synthetic variable is no trivial task at all. If there are no nominantas on the list of ratios used to create the synthetic ratio, and if the Gaussian distribution of each of those ratios has the form of – $X_j \sim N(\mu_j, \sigma_j)$, then the standardized ratios will be characterized by the standardized Gaussian distribution in the form of – $X'_j \sim N(0, 1)$. Representing the synthetic financial performance ratio calculated in accordance with formula (12) and estimated on the basis of m independent samples generated randomly from such distributions, the mean will also be characterized by the Gaussian distribution, in which case the distribution of the synthetic financial performance ratio could be expressed in the following way:

$$\bar{X}' \sim N(0, \frac{1}{\sqrt{m}}), \tag{13}$$

with the distribution function of the synthetic financial performance ratio expressed as follows:

$$F(\bar{x}') = P\{\bar{X}' \leq \bar{x}'\}. \tag{14}$$

In most cases, however, in the set of ratios defining a financial performance there are nominantas to be found. And should this be the case, the transformation of a nominanta into a stymulanta carried out in accordance with formula (7) most rarely triggers a situation where the distribution of such a transformation is the Gaussian one. What is more, it should take the form of a mixture composed of continuous and discrete distributions. This should happen if ratios of certain objects belong to the recommended interval. If this condition is met, then the probability mass will concentrate at point $\frac{-\bar{x}_j}{s_j}$. Because of that, a strong left-sided asymmetry should also be expected. Should this be the case, no analytical calculation of the distribution of the $\bar{X}'$ synthetic financial performance ratio is possible in general. Such a distribution has to be calculated each time as a resultant of distributions that characterize financial ratios creating the synthetic one. The distribution of the $\bar{X}'$ synthetic ratio, however, can be calculated on the basis of empirical distributions characterizing individual normalized financial ratios. To do this, the authors of this paper suggest the Monte Carlo simulation be applied in accordance with the procedure presented below:

1. Define N number of samples.

2. For each sample, values of the $X'_1, X'_2, \ldots, X'_m$ financial ratios that are first transformed in accordance with formulas (6) and (7), and then normalized in accordance with formula (5) are randomly generated. The set of values of the j-th normalized X'_j ratio is the set of its empirical values. The probability of each x'_j value being sampled is equal to k/n, where k signifies the multiplicity of a given value belonging to the set of empirical values, and n indicates the number of companies.

3. The synthetic financial performance ratio is calculated on the basis of generated values in accordance with formula (12).

4. Sampling is repeated N times. As a result, N synthetic ratio values are obtained with a view to calculating the distribution of the synthetic financial performance ratio.

5. Using the distribution function of the synthetic financial performance ratio, it is possible to decipher for a given company the percentage of companies whose financial performance is worse or equal to that of the company we took our interest in. The relevant value is equal to the distribution function of the $\overline{X}'$ variable, i.e. it is the target $F(\overline{x}')$ value from formula (14).

The approximation of the $\overline{X}'$ distribution achieved via the Monte Carlo simulation depends mainly on the number of samples and the amount of variables X'_j in the empirical set. Compared to the analytical solution, the loss resulting from this distribution being calculated less accurately is misleading, since the analytical solution requires that an assumption about the form of the X'_j variable distribution is made on the basis of the X'_j empirical set, and as such it is prone to miscalculation. The chief asset of the Monte Carlo simulation is the fact that it can be carried out equally well for discrete, continuous and mixed distributions.

6. Empirical example – ZPC Mieszko S.A.'s financial performance evaluation and forecast

6.1. Selecting financial ratios

The main criterion for selecting financial ratios was the need for companies being as different from each other as possible. Therefore such financial ratios have been proposed that should not potentially be strongly mutually correlated. The following financial ratios have been proposed with a view to the creation of the synthetic variable:

$$\text{ROA} = \frac{\text{net income}}{\text{total assets}} \tag{15}$$

$$\text{ROS} = \frac{\text{gain (loss) on sale}}{\text{net sales revenue}} \tag{16}$$

$$\text{Current ratio} = \frac{\text{current assets}}{\text{short-term liabilities}} \tag{17}$$

$$\text{Debt ratio} = \frac{\text{liabilities and provisions for liabilities}}{\text{total liability}} \tag{18}$$

$$\text{Asset turnover ratio} = \frac{\text{net sales revenue}}{\text{total assets}} \tag{19}$$

$$\text{Operating cycle ratio} = \frac{365 \times (\text{receivables} + \text{inventories})}{\text{net sales revenue}} \tag{20}$$

Table 1. Financial ratios of confectionery companies

Company	ROA	ROS	Current ratio	Debt ratio	Asset turnover ratio	Operating cycle ratio
ASTRA PPHU Sp. z o.o.*	0.089	0.067	1.28	0.208	1.55	48
BARRY Callebaut Manufacturing Polska Sp. z o.o.	0.180	0.099	2.07	0.604	2.42	116
CADBURY WEDEL Sp. z o.o.*	0.054	0.082	2.96	0.361	0.91	98
Cukiernia MISTRZA JANA Sp. z o.o.*	–0.253	0.002	0.75	0.860	2.62	53
CSI Jedność*	0.060	–0.055	2.47	0.313	1.32	125
Dr Kendy S.A.	–0.049	0.044	1.77	1.175	0.21	910
Dr. Oetker Dekor Sp. z o.o.	0.409	0.027	4.32	0.102	1.03	77
EWA PPH S.A.	0.045	0.045	4.64	0.137	1.26	125
FERRERO POLSKA Sp. z o.o.	0.099	0.111	1.62	0.474	1.49	109
FC Solidarność Sp. z o.o.*	0.069	0.042	1.51	0.476	1.52	105
FOODCARE Sp. z o.o.*	0.072	0.061	1.24	0.522	1.94	105
Grupa DELIC-POL Sp. z o.o.	0.054	0.078	1.32	0.655	1.05	127
HILDEBRAND ZPC s.j.	0.021	–0.006	0.98	0.653	1.37	128
Jutrzenka Colian Sp. z o.o.	0.032	0.389	1.20	0.204	0.50	105
Kopernik FC S.A.	0.039	0.035	3.23	0.178	1.49	138
Kraft Foods Polska S.A.	0.163	0.147	3.63	0.259	1.30	53
KRUGER Polska Sp. z o.o.	0.007	–0.005	3.09	0.034	1.78	127
LUDWIG Czekolada Sp. z o.o.	0.044	0.056	0.53	0.525	1.48	58
MARS Polska Sp. z o.o.*	0.131	0.080	1.62	0.473	2.23	64
MASPEX-GMW Sp. z o.o.*	0.113	0.053	2.73	0.166	0.37	187
Nadwiślanka S.A.*	0.010	–0.001	1.23	0.592	4.60	44
NESTLE Polska S.A.*	0.170	0.111	1.44	0.529	2.00	85
PPC GRYF S.A.*	0.013	0.015	1.13	0.705	1.86	123
PWC Odra S.A.	0.030	0.012	0.99	0.704	1.85	102
ROKSANA Cukiernicza Spółdzielnia*	0.024	–0.135	3.51	0.345	1.28	107
Spółdzielnia POKOJ*	0.162	–0.015	3.79	0.273	2.06	74
STORCK Sp. z o.o.*	0.166	0.044	1.63	0.743	3.94	58
TERRAVITA Sp. z o.o.	0.010	0.011	1.40	0.732	2.47	127
UNION CHOCOLATE Sp. z o.o.	0.165	0.087	7.48	0.110	1.25	133
WOLNOŚĆ Sp. z o.o.	0.021	0.047	0.78	0.990	3.93	55
ZPC Bałtyk Sp. z o.o.	–0.053	–0.005	2.53	0.375	3.20	96
ZPC MIESZKO S.A.	0.038	0.384	0.83	0.540	1.06	137
ZPC Otmuchów S.A.	0.097	0.236	1.21	0.603	1.42	111
ZPC Skawa S.A.	0.001	–0.001	0.87	0.484	2.44	50
ZPC Wawel S.A.	0.128	0.435	2.47	0.251	1.25	123
ZPH Argo Sp. z o.o.	0.043	0.066	0.67	0.723	1.38	84
ZWC Miś Sp. z o.o.	–0.004	–0.014	1.60	0.438	1.48	116

* Data as of 2008.

Source: authors' calculations carried out on the basis of data from the emerging markets database.

Thirty seven companies operating in the confectionery industry were covered in the study. All of them can be classified as the most direct competitors of the ZPC Mieszko S.A. company. For each company, financial ratios were calculated on the basis of their financial statements for the year of 2009 and partially 2008. Table 1, including values of financial ratios calculated for individual companies, has been presented below.

6.2. The structure of the synthetic financial performance measurement tool

For the sake of further analysis, all variables need to be transformed into stymulantas. The ROA, ROS and asset turnover ratios are all stymulantas. The operating cycle ratio is a destymulanta, therefore the transformation should be carried out in accordance with formula (6). The current ratio is a nominanta with a recommended level of 1.2 – 2.0, and the debt ratio is a nominanta with a recommended level of 0.5 – 0.7 (see: for instance [Sierpińska 2004, p. 147, 167; Bednarski 2007, p. 79]. These ratios' values have been transformed in accordance with formula (7). Table 2, including values of individual ratios after their transformation into stymulantas, has been presented below.

Table 2. Companies' financial ratios transformed into stymulantas

Company	ROA	ROS	Current ratio	Debt ratio	Asset turnover ratio	Operating cycle ratio
1	2	3	4	5	6	7
ASTRA PPHU Sp. z o.o.	0.089	0.067	0.000	–0.292	1.55	–48
BARRY Callebaut Manufacturing Polska Sp. z o.o.	0.180	0.099	–0.068	0.000	2.42	–116
CADBURY WEDEL Sp. z o.o.	0.054	0.082	–0.962	–0.139	0.91	–98
Cukiernia MISTRZA JANA Sp. z o.o.	–0.253	0.002	–0.454	–0.160	2.62	–53
CSI Jedność	0.060	–0.055	–0.471	–0.187	1.32	–125
Dr Kendy S.A.	–0.049	0.044	0.000	–0.475	0.21	–910
Dr. Oetker Dekor Sp. z o.o.	0.409	0.027	–2.315	–0.398	1.03	–77
EWA PPH S.A.	0.045	0.045	–2.638	–0.363	1.26	–125
FERRERO POLSKA Sp. z o.o.	0.099	0.111	0.000	–0.026	1.49	–109
FC Solidarność Sp. z o.o.	0.069	0.042	0.000	–0.024	1.52	–105
FOODCARE Sp. z o.o.	0.072	0.061	0.000	0.000	1.94	–105
Grupa DELIC-POL Sp. z o.o.	0.054	0.078	0.000	0.000	1.05	–127
HILDEBRAND ZPC s.j.	0.021	–0.006	–0.224	0.000	1.37	–128
Jutrzenka Colian Sp. z o.o.	0.032	0.389	0.000	–0.296	0.50	–105
Kopernik FC S.A.	0.039	0.035	–1.232	–0.322	1.49	–138

1	2	3	4	5	6	7
Kraft Foods Polska S.A.	0.163	0.147	–1.635	–0.241	1.30	–53
KRUGER Polska Sp. z o.o.	0.007	–0.005	–1.087	–0.466	1.78	–127
LUDWIG Czekolada Sp. z o.o.	0.044	0.056	–0.667	0.000	1.48	–58
MARS Polska Sp. z o.o.	0.131	0.080	0.000	–0.027	2.23	–64
MASPEX-GMW Sp. z o.o.	0.113	0.053	–0.731	–0.334	0.37	–187
Nadwiślanka S.A.	0.010	–0.001	0.000	0.000	4.60	–44
NESTLE Polska S.A.	0.170	0.111	0.000	0.000	2.00	–85
PPC GRYF S.A.	0.013	0.015	–0.074	–0.005	1.86	–123
PWC Odra S.A.	0.030	0.012	–0.209	–0.004	1.85	–102
ROKSANA Cukiernicza Spółdzielnia	0.024	–0.135	–1.511	–0.155	1.28	–107
Spółdzielnia POKOJ	0.162	–0.015	–1.792	–0.227	2.06	–74
STORCK Sp. z o.o.	0.166	0.044	0.000	–0.043	3.94	–58
TERRAVITA Sp. z o.o.	0.010	0.011	0.000	–0.032	2.47	–127
UNION CHOCOLATE Sp. z o.o.	0.165	0.087	–5.475	–0.390	1.25	–133
WOLNOŚĆ Sp. z o.o.	0.021	0.047	–0.423	–0.290	3.93	–55
ZPC Bałtyk Sp. z o.o.	–0.053	–0.005	–0.534	–0.125	3.20	–96
ZPC MIESZKO S.A.	0.038	0.384	–0.370	0.000	1.06	–137
ZPC Otmuchów S.A.	0.097	0.236	0.000	0.000	1.42	–111
ZPC Skawa S.A.	0.001	–0.001	–0.331	–0.016	2.44	–50
ZPC Wawel S.A.	0.128	0.435	–0.466	–0.249	1.25	–123
ZPH Argo Sp. z o.o.	0.043	0.066	–0.531	–0.023	1.38	–84
ZWC Miś Sp. z o.o.	–0.004	–0.014	0.000	–0.062	1.48	–116

Source: authors' calculations.

The next step was to carry out the standardization of financial ratios in accordance with formula (5). Descriptive parameters of individual ratios that were used in the standardization process have been presented in Table 3. Table 4 includes a juxtaposition of normalized values of financial ratios.

Table 3. Distribution parameters characterizing ratios transformed into stymulantas

Parameter	ROA	ROS	Current ratio	Debt ratio	Asset turnover ratio	Operating cycle ratio
Average	0.06	0.07	–0.65	–0.15	1.77	–121
Standard deviation	0.10	0.12	1.05	0.15	0.94	135

Source: authors' calculations.

Table 4. Normalized company financial ratios

Company	ROA	ROS	Current ratio	Debt ratio	Asset turnover ratio	Operating cycle ratio
ASTRA PPHU Sp. z o.o.	0.25	–0.03	0.62	–0.95	–0.22	0.54
BARRY Callebaut Manufacturing Polska Sp. z o.o.	1.17	0.24	0.56	0.94	0.70	0.04
CADBURY WEDEL Sp. z o.o.	–0.12	0.10	–0.29	0.04	–0.91	0.17
Cukiernia MISTRZA JANA Sp. z o.o.	–3.24	–0.60	0.19	–0.09	0.91	0.51
CSI Jedność	–0.05	–1.09	0.17	–0.27	–0.48	–0.02
Dr Kendy S.A.	–1.16	–0.23	0.62	–2.14	–1.66	–5.83
Dr. Oetker Dekor Sp. z o.o.	3.51	–0.38	–1.58	–1.64	–0.78	0.32
EWA PPH S.A.	–0.20	–0.23	–1.88	–1.41	–0.54	–0.03
FERRERO POLSKA Sp. z o.o.	0.35	0.35	0.62	0.77	–0.29	0.09
FC Solidarność Sp. z o.o.	0.04	–0.25	0.62	0.79	–0.26	0.12
FOODCARE Sp. z o.o.	0.08	–0.09	0.62	0.94	0.19	0.12
Grupa DELIC-POL Sp. z o.o.	–0.11	0.06	0.62	0.94	–0.77	–0.04
HILDEBRAND ZPC s.j.	–0.44	–0.67	0.41	0.94	–0.42	–0.05
Jutrzenka Colian Sp. z o.o.	–0.33	2.76	0.62	–0.98	–1.35	0.12
Kopernik FC S.A.	–0.26	–0.31	–0.55	–1.15	–0.29	–0.13
Kraft Foods Polska S.A.	1.00	0.66	–0.93	–0.62	–0.50	0.50
KRUGER Polska Sp. z o.o.	–0.59	–0.66	–0.41	–2.08	0.01	–0.04
LUDWIG Czekolada Sp. z o.o.	–0.22	–0.13	–0.01	0.94	–0.30	0.46
MARS Polska Sp. z o.o.	0.68	0.08	0.62	0.77	0.50	0.42
MASPEX-GMW Sp. z o.o.	0.49	–0.16	–0.07	–1.23	–1.49	–0.49
Nadwiślanka S.A.	–0.56	–0.62	0.62	0.94	3.02	0.57
NESTLE Polska S.A.	1.07	0.34	0.62	0.94	0.25	0.27
PPC GRYF S.A.	–0.53	–0.49	0.55	0.91	0.10	–0.02
PWC Odra S.A.	–0.36	–0.51	0.42	0.91	0.09	0.14
ROKSANA Cukiernicza Spółdzielnia	–0.42	–1.79	–0.81	–0.07	–0.52	0.11
Spółdzielnia POKÓJ	1.00	–0.74	–1.08	–0.53	0.32	0.35
STORCK Sp. z o.o.	1.03	–0.24	0.62	0.66	2.32	0.47
TERRAVITA Sp. z o.o.	–0.56	–0.52	0.62	0.74	0.75	–0.04
UNION CHOCOLATE Sp. z o.o.	1.02	0.14	–4.58	–1.59	–0.55	–0.09
WOLNOŚĆ Sp. z o.o.	–0.45	–0.21	0.22	–0.94	2.31	0.49
ZPC Bałtyk Sp. z o.o.	–1.20	–0.66	0.11	0.13	1.53	0.19
ZPC MIESZKO S.A.	–0.28	2.71	0.27	0.94	–0.75	–0.12
ZPC Otmuchów S.A.	0.33	1.43	0.62	0.94	–0.37	0.08
ZPC Skawa S.A.	–0.65	–0.62	0.31	0.84	0.72	0.52
ZPC Wawel S.A.	0.64	3.15	0.18	–0.67	–0.55	–0.01
ZPH Argo Sp. z o.o.	–0.23	–0.05	0.12	0.79	–0.41	0.28
ZWC Miś Sp. z o.o.	–0.70	–0.74	0.62	0.54	–0.30	0.04

Source: authors' calculations.

Table 5. Correlation coefficients of standardized variables

Ratios	ROA	ROS	Current ratio	Debt ratio	Asset turnover ratio	Operating cycle ratio
ROA	1.00	0.18	–0.32	–0.12	–0.16	0.18
ROS	0.18	1.00	0.11	–0.01	–0.29	0.00
Current ratio	–0.32	0.11	1.00	0.55	0.21	–0.07
Debt ratio	–0.12	–0.01	0.55	1.00	0.34	0.38
Asset turnover ratio	–0.16	–0.29	0.21	0.34	1.00	0.40
Operating cycle ratio	0.18	0.00	–0.07	0.38	0.40	1.00

Source: authors' calculations.

During the next stage, ratios statistically fundamentally correlated were excluded from the set of financial ratios. A statistical analysis of standardized data implies that the debt ratio is fundamentally correlated with the current ratio (p-value = $4.12 \cdot 10^{-4}$) (see Table 5). It indicates that ratios tend to overlap to a significant extent in terms of the information they carry. Including both types of ratios mentioned above in the structure of the synthetic variable would result in one aspect of a financial performance – company's solvency ratio in this particular case – having a greater impact on the ultimate evaluation than others. This is the reason why the current ratio was excluded from the set of variables for the purpose of further analysis.

6.3. Creating a ranking of confectionery companies

On the basis of values of five normalized ratios, the Monte Carlo simulation was carried out in accordance with the procedure described in section 5 of this paper. The sample size was defined as 1 million. The simulation was carried out via the Matlab® R2007a software, with the use of a genuine code created by the authors. The same weight was attached to all ratios. As a result, one million values of synthetic financial performance ratios were generated. The distribution of values of the synthetic ratio along with its basic statistical properties have been shown in Figure 1. The resulting distribution of the synthetic financial performance ratio concentrates close to zero, displays a left-sided asymmetry and, finally, is a leptokurtic one.

Values of the distribution function of the synthetic ratio, which have been presented in Table 6, can be calculated on the basis of its distribution in accordance with formula (14). A ranking of confectionery companies presented below was created on the basis of the said values.

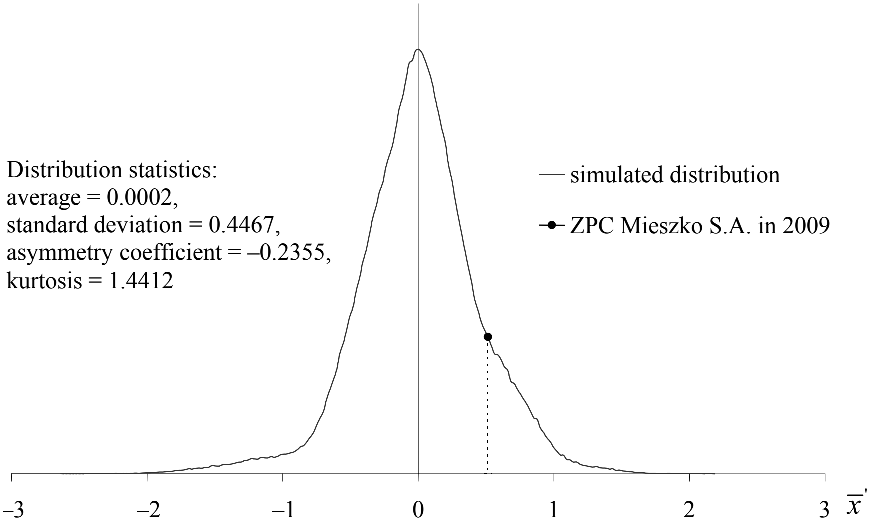

Figure 1. A simulated distribution of the synthetic financial performance ratio calculated for confectionery companies

Source: authors' elaboration.

Table 6. Confectionery company ranking for 2009

Position	Company	Synthetic ratio centile [%]
1	2	3
1	STORCK Sp. z o.o.	96.94
2	Nadwiślanka S.A.	93.29
3	BARRY Callebaut Manufacturing Polska Sp. z o.o.	91.88
4	NESTLE Polska S.A.	90.52
5	ZPC Wawel S.A.	88.40
6	ZPC MIESZKO S.A.	88.05
7	MARS Polska Sp. z o.o.	87.58
8	ZPC Otmuchów S.A.	87.36
9	FERRERO POLSKA Sp. z o.o.	74.71
10	FOODCARE Sp. z o.o.	74.17
11	WOLNOŚĆ Sp. z o.o.	73.44
12	Dr. Oetker Dekor Sp. z o.o.	70.90
13	Kraft Foods Polska S.A.	70.87
14	ZPC Skawa S.A.	66.85
15	LUDWIG Czekolada Sp. z o.o.	65.80
16	FC Solidarność Sp. z o.o.	59.43

1	2	3
17	SPÓŁDZIELNIA POKÓJ	58.47
18	ZPH Argo Sp. z o.o.	58.34
19	TERRAVITA Sp. z o.o.	57.93
20	PWC Odra S.A.	56.19
21	Jutrzenka Colian Sp. z o.o.	54.70
22	Grupa DELIC-POL Sp. z o.o.	51.63
23	ZPC Bałtyk Sp. z o.o.	49.81
24	PPC GRYF S.A.	49.57
25	ASTRA PPHU Sp. z o.o.	40.77
26	HILDEBRAND ZPC s.j.	36.34
27	CADBURY WEDEL Sp. z o.o.	34.85
28	UNION CHOCOLATE Sp. z o.o.	28.59
29	ZWC Miś Sp. z o.o.	26.98
30	CSI Jedność	16.34
31	Kopernik FC S.A.	13.92
32	EWA PPH S.A.	11.31
33	Cukiernia MISTRZA JANA Sp. z o.o.	10.41
34	ROKSANA Cukiernicza Spółdzielnia	9.06
35	MASPEX-GMW Sp. z o.o.	7.78
36	KRUGER Polska Sp. z o.o.	5.31
37	Dr Kendy S.A.	0.01

Source: authors' calculations.

ZPC Mieszko S.A. was sixth in the ranking with the distribution function of its synthetic financial performance ratio amounting to 0.88. What these figures suggest is that in theory ZPC Mieszko displays better financial health than 88% of the remaining companies. At the same time, theoretically speaking, 12% appears to outclass ZPC Mieszko[1].

6.4. Forecasting financial performance of MIESZKO S.A.

In order to forecast the synthetic ratio, a couple of different approaches can be adopted by means of forecasting the following:

– variables constituting financial ratios,
– financial ratios,
– the synthetic ratio.

[1] In fact it is a 5/37 of the surveyed companies that appears to be better than ZPC MIESZKO, i.e. 13.5%.

For the sake of this study the last of the approaches listed above was adopted. Financial ratios calculated on the basis of financial statements created between 1997--2009 by ZPC Mieszko S.A. have been presented in Table 7. These ratios served the purpose of creating the synthetic financial performance ratio. In order to standardize

Table 7. Financial ratios of ZPC Mieszko S.A.

Year	ROA	ROS	Debt ratio	Asset turnover ratio	Operating cycle ratio
1997	0.066	0.257	0.460	0.916	103.1
1998	–0.065	0.186	0.589	0.715	129.1
1999	0.041	0.270	0.605	0.881	144.2
2000	0.039	0.265	0.693	0.875	134.1
2001	0.006	0.258	0.758	0.885	166.5
2002	0.038	0.302	0.687	0.951	137.1
2003	–0.069	0.301	0.809	0.812	115.3
2004	0.001	0.332	0.629	0.904	124
2005	0.007	0.355	0.649	0.867	147.3
2006	0.011	0.362	0.648	0.909	146.7
2007	0.015	0.364	0.640	0.991	142.5
2008	0.027	0.399	0.567	1.028	143.6
2009	0.038	0.384	0.540	1.060	136.5

Source: authors' calculations carried out on the basis of financial statements created by ZPC Mieszko S.A.

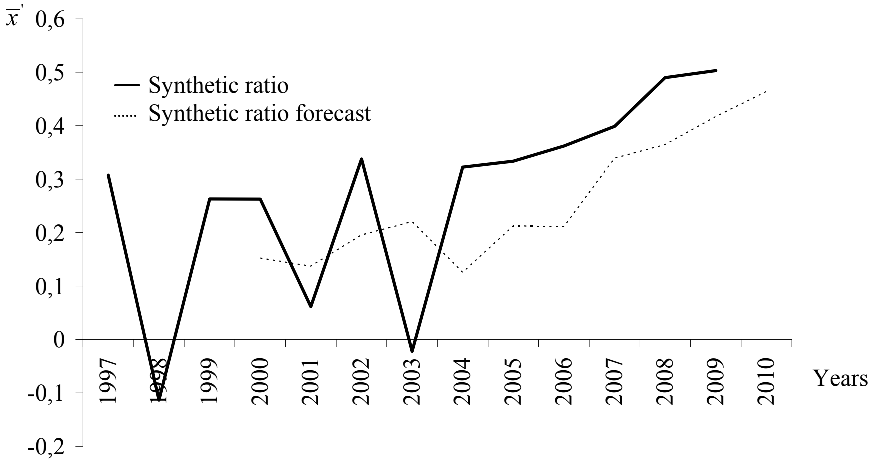

Figure 2. The synthetic financial performance ratio of ZPC Mieszko between 1997-2009. Past forecasts, and the forecast for 2010

Source: own elaboration.

individual ratios, parameters calculated for all companies and included in Table 3 were employed. Having analysed the time series of the synthetic ratio, the authors of this paper decided a moving average line should be employed to generate the forecast. The k = 3 smoothing constant was selected on the basis of minimization of past forecast errors. The synthetic financial performance ratio forecast of ZPC Mieszko for 2010 is equal to $\overline{x}_{2010}^{'*} = 0.464$.

Using the previously calculated distribution of the synthetic ratio, the value of the distribution function can be determined for the forecast:[2]

$$F(\overline{x}_{2010}^{'*}) = 0.8658 \ \ (86.58 \text{ centile}).$$

Assuming that the synthetic financial performance ratio calculated for confectionery companies does not change over the of 2010, the ranking position of ZPC Mieszko will drop from 88 to 86 centile.

7. Conclusion

A company's financial performance is a complex phenomenon. Its full description calls for an analysis of many different aspects of company's business activities. A clear-cut evaluation of a company's financial performance could only be carried out on the condition that different ratios – which often tend to convey contradictory messages – are going to be intertwined, and all at the same time. One way to carry out such an evaluation, which sometimes proves to be the only method applicable in this case, is to create the synthetic ratio.

A synthetic ratio value calculated for a single company is not going to suffice though. To carry out the evaluation there needs to be some kind of a point of reference, a platform which the result could be compared against. There has been no such thing discussed in the specialist literature to date. Therefore, to judge whether the calculated value of the synthetic ratio is good, satisfactory or unsatisfactory is quite difficult. Additionally interpreting the significance of differences between two or more companies is no easy task either. Is a difference of 0.3 in the synthetic ratio just a small gap or an insurmountable one? Finally, do potential differences carry the same importance irrespective of how high or low the two compared synthetic ratio values are?

It is the authors' opinion that the method for analysing the distribution of the synthetic ratio and carrying out an evaluation of a company's financial performance on the basis of the synthetic ratio distribution function presented in this work can solve the interpretative problems mentioned above. The value of the distribution function determines a company's position in the market in an unambiguous way, and at the same time defines it in comparison to a company's individual competitors.

[2] It is worth mentioning here is that the distribution of the synthetic ratio can change with time. Due to many difficulties encountered during the process of gathering data concerning the business activity carried out by the surveyed companies in previous years, the authors of this work assumed for the sake of the synthetic ratio distribution forecast for 2010 that it would not be prone to any changes.

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ZASTOSOWANIE WIELOWYMIAROWEJ ANALIZY PORÓWNAWCZEJ DO OCENY I PROGNOZY KONDYCJI FINANSOWEJ PRZEDSIĘBIORSTWA NA TLE BRANŻY

Streszczenie: Kondycja finansowa jest zjawiskiem złożonym. Do jego wyczerpującego opisu należy wykorzystać co najmniej kilka wskaźników finansowych. W artykule rozważano problemy oceny i prognozy kondycji finansowej na tle innych przedsiębiorstw funkcjonujących w branży. W badaniach wykorzystano metody wielowymiarowej analizy porównawczej oraz metodę symulacji Monte Carlo. Zaproponowano procedurę budowy rankingu przedsiębiorstw bazującą na dystrybuancie rozkładu syntetycznego wskaźnika kondycji finansowej.