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APPLICATION OF SYNTHETIC TAXONOMIC MEASURES TO ASSESS THE INVESTMENT ATTRACTIVENESS OF THE SELECTED COMPANIES IN THE CONSTRUCTION MATERIALS INDUSTRY LISTED ON THE WARSAW STOCK EXCHANGE

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Abstract: The study used the synthetic taxonomic measure TMAI and BZW to determine whether the fundamental strength of 17 companies from the construction material industry listed on the Warsaw Stock Exchange affects their investment performance. Companies whose operations are conducted mainly in Poland and whose profit and loss account is prepared in the calculation system were selected for the study. It was checked how the use of different methods of aggregation of the same diagnostic variables (with and without a pattern) affects the classification results. Investment efficiency was measured with the annual, logarithmic rate of return and the created rankings of companies for the years 2016-2021 were compared with it.

Keywords: synthetic taxonomic measure, TMAI, BZW, building materials company, Warsaw Stock Exchange

JEL classification: C1, G11

INTRODUCTION

The development of the economy and markets has meant that the demand for specialized tools to support and facilitate decision-making is constantly growing. In practice, each decision is multidimensional, which results from the interaction of many phenomena. This is especially evident in the field of economics. The effectiveness of action in a complex economic reality is determined by good and

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reliable information and its proper processing, so that decisions made on its basis are effective [Łuniewska, Tarczyński 2006].

Assessment of the investment attractiveness of listed companies is a complex process that includes multidimensional comparative analysis and interdependence research, i.e., methods related to fundamental analysis. It mainly concerns long-term investing. It refers to the study of the foundations on which the share price is based, and one of the factors determining the formation of these prices in the long term is the financial condition of the company [Jajuga and Jajuga 2000].

The methods of linear ordering of objects are one of the groups of Multidimensional Comparative Analysis methods. In the literature, you can find many algorithms for creating synthetic measures that use properly selected diagnostic variables. Z. Hellwig [1968) was the first to propose a synthetic measure of development to compare the level of economic development of selected countries. Since then, the methodology of constructing taxonomic measures for various applications has been developed in Poland by, among others, Cieślak [1974]; Bartosiewicz [1976]; Strahl [1978]; Zeliaś, Malina [1997]; Kukuła [1986, 2000]; Walesiak [2003]; Gatnar, Walesiak [2004] as well as Tarczyński and Łuniewska [2006].

In the works of Tarczyński [1994, 2002] and Łuniewska and Tarczyński [2006], the authors proposed the use of fundamental analysis in the construction of a taxonomic measure of investment attractiveness (TMAI) based on publicly available indicators of the financial condition of the company and the development of the capital market. The concept of an algorithm created by Hellwig [1968] was used to build the meter.

The main aim of the study is to assess the fundamental strength of 17 companies from the construction materials industry listed on the Warsaw Stock Exchange using two taxonomic measures TMAI and BZW and its impact on investment performance. Rankings for the years 2016-2021 were built and it was checked how the use of different methods of aggregation of the same diagnostic variables [with and without a pattern] affects the classification results. As a measure of investment efficiency, annual, logarithmic rates of return were used, with which the obtained results of the classification of the surveyed companies were compared. The work uses: taxonomic measure of investment attractiveness (TMAI), in which the distance from the pattern is calculated for each object, taking into account the different impact of variables on the studied phenomenon, and the relative level of development index (BZW) calculated without a pattern. These measures allow for a comprehensive analysis of enterprises based on the most important financial indicators, presenting it in the form of a ranking.

The very important role of the construction industry results from the implementation of investments present in everyday life of almost everyone and the ability to generate economic growth. Analyses of the construction market and the construction materials industry are carried out on many levels. They are important from the point of view of the needs of the sector's enterprises themselves, who want

to achieve an adequate profit from their operations, but also from the point of view of the needs of households, who are customers and investors. The article is a continuation of the author's research on the possibility of an objective fundamental assessment of companies from the construction industry and the construction materials industry. Hence, it is advisable to select 17 companies for the analysis, including two companies whose shares were delisted from the stock exchange in 2020 (ES-System S.A.) and in 2021 (Ceramika Nowa Gala S.A.). It is assumed that the companies that have been delisted are at the bottom of the fundamental valuation scale. This allows the positions of the remaining companies to be compared.

LITERATURE REVIEW

The fundamental strength of a company is a term used for the first time in the work of Tarczyński [1994] and is a concept closely related to fundamental analysis, which allows to determine the economic and financial condition of a company. In recent years, an increasing role of fundamental factors in the market assessment of companies can be observed.

Benjamin Graham is considered to be the creator of the concept of using fundamental analysis methods in the investment process [Graham, Dodd, 2005; Graham, 2007]. The concept of fundamental strength has evolved in the literature on the subject, often not being referred to as such [Tarczyński et al., 2017].

A whole range of practical applications of fundamental analysis to assess the value of listed companies can be found in many works.

Among others, in the article by Mrzygłód and Nowak [2013], fundamental analysis was used to assess the investment strength of the Warsaw Stock Exchange itself after the demutualization process. The authors presented the conclusions that in the years following the IPO [November 9, 2010] an improvement in the operating results of the WSE could be observed, which had an impact on investors' decisions.

Using the idea of a taxonomic measure of investment attractiveness [TMAI], Juszczyk [2015] in her work assessed the financial condition of companies from the food sector listed on the Warsaw Stock Exchange. The study was conducted from data from 2012. In addition, the author compared the TMAI values with the actual rates of return in the same period and showed a statistically significant, although weak, correlation between the average synthetic measures of investment attractiveness changing over time and the rates of return for the surveyed enterprises.

Empirical studies for companies listed on the Warsaw Stock Exchange using TMAI and BZW measures can be found in Tarczyński and Łuniewska's [2004b, 2006] papers, where the authors constructed investment portfolios, and in the article by Zielińska-Sitkiewicz [2015] article, which analysed the fundamental strength of food sector companies. In addition, the efficiency of Chinese banks was assessed using BZW and TMAI in the paper by Witkowska [2010].

The aim of the authors, Muhammad and Gohar [2018], was to examine the ability of historical accounting data to predict future twists and turns using

fundamental analysis. Data was collected for an eleven-year period from 2007 to 2017 for 115 non-financial companies listed on the Karachi Stock Exchange [KSE] in Pakistan. In the paper, four indicators from different areas were used, i.e. profitability ratios, liquidity ratios, leverage ratios and market-based ratios. For the purpose of the analysis, the authors used the penal data analysis [common effect model, fixed effect model, and random effect model]. The results indicated that the fundamental analysis can predict future stock returns in Pakistani listed companies.

In turn, Bintara, Wahyudi and Molina [2019] assessed the impact of selected financial ratios: Return On Assets (ROA), Current Ratio (CR), Debt to Equity Ratio (D/E), Price to Earnings Ratio (P/E) and Price to Book Value (P/B) per stock price. For the years 2012-2016, the authors examined banking companies that are included in the Kompas 100 index listed on the Indonesian Stock Exchange (IDX). Multiple regression tests were used as the analytical method to test the hypothesis. The results show that ROA and CR are positively related to the share price, but D/E affects the share price negatively. P/E is positively but insignificantly related to the share price and P/B has no effect on it.

In the article by the authors of Witkowska, Kuźnik [2019], a study was conducted on the impact of the company's fundamental strength on its investment performance. The analysis covered 27 non-financial companies listed on the Warsaw Stock Exchange, belonging to the WIG20 and mWIG40 portfolios. The results obtained by the authors for the years 2012-2017 indicated that the proposed synthetic TMAI measure makes it possible to estimate the fundamental strength of listed companies. In addition, a positive, but mostly statistically insignificant, correlation was found between the values of the constructed measure and the rates of return.

In the work of Tan, Wang, Xiong, Liu [2022], the authors attempted to examine the relationship between fundamentals and stock returns on Chinese stock markets. From 27 fundamental variables including: firms' basic information, valuations, profitability, operational efficiency, quality, inventory, sales expenses and growth, they selected 8 for the study: asset growth, return on assets, profit margin, earnings per share, gross profitability, leverage, current assets to net assets and current liabilities to total liabilities. The results of the analysis showed that fundamental factors and price factors are complementary in predicting future returns on stocks in the Chinese market. In turn, in the study of one-factor fundamental strategies, the one based on ROA turned out to be the most effective.

METHODOLOGY AND DATA

Seventeen listed companies from the construction materials industry sector, listed on the main market of the Warsaw Stock Exchange since at least 2010, whose activities are conducted mainly in Poland and whose profit and loss account is prepared in the calculation system, were selected for the study.

From the point of view of the nature of the business conducted by the analysed companies, they can be divided according to the following criteria:

- companies specializing in the production of interior finishing materials: Decora S.A., Ceramika NovaGala S.A., Ferro S.A., ES-System S.A., Lentex S.A., Pozbud S.A., Śnieżka S.A.;
- companies whose production focuses on prefabricated elements and products for the construction industry: Izolacja-Jarocin S.A., Izostal S.A., KBDom S.A., Lena Lighting S.A., Libet S.A., Mercor S.A., MFO S.A., Ropczyce S.A., Selena FM S.A., ULMA Construction S.A.

When analysing the data on sales revenues for all enterprises, it should be noted that from 2016 to 2021 they have been growing steadily, with different growth dynamics. The lowest increase in revenues was recorded in 2019/2018 and amounted to only 2.8%, and the highest in 2021/2020 and accounted for nearly 18%, despite the inclusion of a depleted group of 15 companies in 2021 [see table 1]. In the years of the 2021/2020 pandemic, the revenues of companies producing prefabricated elements and materials for the construction industry increased by 24.6%, and by companies on the interior finishing materials market by 7.6%.

Table 1. Sales revenues in thousands of PLN

	Sales Revenue					
COMPANY	**2021**	**2020**	**2019**	**2018**	**2017**	**2016**
all	**7679489**	**6509195**	**6171670**	**6003806**	**5594936**	**5046265**
Ceramika Nowa Gala S.A.		87078	145825	150322	156609	170982
Decora S.A.	480585	370809	306290	277570	234745	208537
ES-System S.A.		171297	211056	191731	189699	182131
Ferro	830503	519090	451257	405571	364680	332490
FFiL Śnieżka S.A.	794863	821330	717082	586777	564481	575636
Izolacja-Jarocin S.A.	30523	26326	27681	27631	28764	22091
Izostal S.A.	795889	860051	770331	808128	563996	379878
Korporacja Budowlana Dom S.A.	14420	12610	12543	39467	120110	140218
Lena Lighting S.A.	148426	132728	118387	130289	137134	130483
Lentex S.A.	412233	372354	320840	477469	478677	488029
Libet S.A.	284475	250178	199967	177891	288206	284236
Mercor S.A.	386186	396066	370919	370919	318467	269498
MFO S.A.	990376	422481	437439	414303	366227	256080
Pozbud T&R S.A.	210916	193746	197009	130458	126097	167564
Ropczyce S.A.	361893	297673	329192	363588	277044	244106
Selena Fm S.A.	1728350	1384735	1326486	1227971	1178706	1013819
Ulma Construccion Polska S.A.	209851	190643	229366	223721	201294	180487

Source: self - elaboration based on financial statements of companies

The COVID-19 pandemic did not significantly slow down the construction sector in Poland and in the world, as shown in the annual reports of *The Global Powers of Construction* prepared by Deloitte, and the recorded increase in the revenues of the surveyed companies at that time was primarily influenced by significant increases in the prices of raw materials and materials. In 2021, the highest increase in revenues was generated by MFO S.A. (by 134.4%) and Ferro S.A. (by 59.9%) companies, and slight decreases were recorded by Izostal S.A. (by 7.5%), Śnieżka S.A. (by 3.2%) and Mercor S.A. (by 2.5%).

When examining the net financial result achieved by companies producing construction materials, it can be seen that the net profit for the entire group recorded the lowest level in 2017, and steadily increased in subsequent years. Companies on the interior finishing materials market in 2020 recorded a spectacular three-fold increase in the net profit (see table 2). This could have been a positive side effect of the Covid-19 pandemic, as research shows that in 2020 every fifth Pole decided to renovate their own flat. Compared to other surveyed companies, the following companies stand out positively: MFO S.A., Ferro S.A., Selena S.A., Izostal S.A., Decora S.A. and Śnieżka S.A., which in the years 2016-2021 systematically improved their financial results. In addition, it should be noted that the surveyed group of companies invests a significant part of its sales on foreign markets, achieving high revenues from exports.

Table 2. Net income/net loss in thousands of PLN

	Net Income / Net Loss					
COMPANY	**2021**	**2020**	**2019**	**2018**	**2017**	**2016**
all	**648650**	**468453**	**254772**	**256701**	**104752**	**245847**
Ceramika Nowa Gala S.A.		2872	-103463	-21146	-5334	-8950
Decora S.A.	66686	56623	25282	20021	15037	13035
ES-System S.A.		-7422	7905	5608	7024	3290
Ferro	109569	62080	40000	37709	11064	29087
FFiL Śnieżka S.A.	64340	86194	62647	63389	56692	53930
Izolacja-Jarocin S.A.	1258	1663	688	810	1202	448
Izostal S.A.	19551	15177	13031	14473	9136	7093
Korporacja Budowlana Dom S.A.	-4992	-3031	-2589	-25661	-102418	-6540
Lena Lighting S.A.	9108	12277	6122	7246	10782	-11582
Lentex S.A.	40526	42773	21623	35144	41045	73953
Libet S.A.	-13423	-1637	17778	-30749	-21299	-6072
Mercor S.A.	29521	23363	15261	14817	11024	3795
MFO S.A.	132964	26953	25410	27901	20715	17774
Pozbud T&R S.A.	34435	28712	11829	6717	7621	6416
Ropczyce S.A.	31432	27559	27367	26765	11397	25029
Selena Fm S.A.	102697	74108	39680	26660	6839	32249
Ulma Construccion Polska S.A.	24978	20189	46201	46997	24225	12892

Source: self - elaboration based on financial statements of companies

All studied companies were subjected to a fundamental analysis. A group of nine financial indicators recommended by the literature [Łuniewska, Tarczyński, 2004a, 2006] was used for the construction of the synthetic Measure of Attractiveness of the Investment (TMAI) for companies in the building materials industry. They characterise the most important aspects of the company activity: profitability (*ROE, ROA, ROS*), liquidity (*CR*), efficiency *(ITR, LR, ATR, RTR*) and debt (*DR*).

Table 3 presents the formulas for calculating the selected indicators recommended in the paper by Tarczyński and Łuniewska [Łuniewska, Tarczyński, 2004a, 2006] and their impact on the general criterion.

Table 3. The selection of variables and their impact on the general criterion

Ratio	Formula	The impact on the general criterion
Return on Equity (*ROE*)	*Net Income / Shareholder Equity*	stimulant
Return on Assets (*ROA*)	*Net Income / Average Total Assets*	stimulant
Return on Sale (ROS)	*Net Income / Sales Revenue*	stimulant
Inventory Turnover Ratio (ITR)	*Net Sales / Average Inventory*	stimulant
Liabilities Ratio (*LR*)	*(Average Liabilities / Net Income)* * 365	stimulant
Asset Turnover Ratio (ATR)	*Net Sales Revenue / Average Total Assets*	stimulant
Receivable Turnover Ratio (*RTR*)	*Sales Revenue/ Average Receivables*	nominant (7 – 10)
Current Ratio (*CR*)	*Current Assets / Current Liabilities*	nominant (1.0 – 1.2)
Debt Ratio (*DR*)	*Total Liabilities / Total Assets*	nominant (57%-67%)

Source: self - elaboration based on papers by Tarczyński and Łuniewska [2006]

In the first stage of the study, all variables were transformed as part of the standardization process - formula (1) for determining the value of the TMAI measure.

$$z_{ij} = \frac{x_{ij} - \overline{x}_j}{S_j}, \tag{1}$$

$\overline{x}_j$ - mean for j-th variable

S_j - standard deviation for j-th variable

Due to the specificity of the variables, Current Ratio (*CR*), Debt Ratio (*DR*) and Receivable Turnover Ratio (*RTR*) were individually transformed from nominants into stimulants according to the formula:

$$x_{ij}^{s} = \frac{\min\left\{x_j^N ; x_{ij}^N\right\}}{\max\left\{x_j^N ; x_{ij}^N\right\}} \tag{2}$$

x_j^N - nominal level of *j-th* variable,

x_{ij}^N - value of *j-th* nominant in *i-th* object.

A detailed description of the criteria for normalization of variables and transformation of indicators into stimulants was presented in the works of Walesiak [2004, 2014] and Zielińska-Sitkiewicz [2017].

In the second stage of the study, according to the procedure described by Tarczyński and Łuniewska [2005, 2017], the Taxonomic Measure of Attractiveness of the Investment was determined for each analysed period 2016 – 2021, where the distance of each object is calculated from the pattern, taking into account the different influence power of the financial ratios on the analysed investment

attractiveness of the companies. The formula for calculating the distance from the pattern is as follows:

$$d_i = \sqrt{\sum_{j=1}^{m} w_j (z_{ij} - z_{0j})^2}, \qquad (i = 1,\ 2,\ldots,n), \tag{3}$$

z_{ij} - standardized value of the attribute *j* for the object *i*,

z_{0j} - maximum value of z_{ij} for the object *i*.

In the study, in order to identify possible differences in the rankings, it was decided to compare the synthetic measure of investment attractiveness - TMAI, calculated with the weights for the financial indicators, with the taxonomic measure BZW, calculated without the weights.

The weights for the financial indicators used were adopted in accordance with the expert method. The group of experts consisted of representatives from the accounting and financial professions. It was found that profitability ratios have the greatest impact on the assessment of the company's situation. This is followed by ratios related to the working capital. Indicators relating to balance sheet items that may result from one-time events, e.g. on December 31, have a relatively low information potential. According to the above findings, the following weights have been selected: profitability ratios *ROE, ROA* and *ROS* - weight of 0.2; liquidity ratio *CR* and debt ratio *DR* - weight of 0.1; efficiency ratios *ITR, LR, ATR, RTR* - weight of 0.05.

The following formula is used to determine the TMAI measure based on the given distance from the pattern:

$$TMAI_i = 1 - \frac{d_i}{d_0}, \qquad (i = 1,\ 2,\ldots,n), \tag{4}$$

$TMAI_i$ – synthetic measure for the object *i*,

d_i – distance between the object *i* and pattern object,

d_0 – norm assuring that $TMAI_i$ reaches values ranging from 0 to 1calculated according to the formula:

$$d_0 = \bar{d} + k \cdot S_d, \tag{5}$$

$\bar{d}$ – average value of d_i

S_d – standard deviation of d_i

and *k* is the constant determined as:

$$k \geq \frac{d_{i\max} - \bar{d}}{S_d}, \tag{6}$$

$d_{i\max}$ – is the maximum value of d_i.

The next stage of the work involved determining the BZW measure for the years 2016-2021. The same criteria were used to normalize the variables and transform the indicators into stimulants as in the TMAI calculation. However, the BZW calculation did not include weights for the financial indicators used. The following equation has been applied:

$$BZW_i = \frac{\sum_{j=1}^{k} z_{ij}}{\sum_{j=1}^{k} \max_{i} \left\{ z_{ij} \right\}}, \quad z_{ij} = x_{ij}^{*} + \left| \min_{i} \left\{ x_{ij}^{*} \right\} \right|, \tag{7}$$

x_{ij}^{*} – standardized value of the variable x_{ij}.

In the last stage, annual logarithmic rates of return were calculated, according to the formula:

$$R_{it} = \ln\left(\frac{y_{it}}{y_{it_0}} \right), \qquad (i = 1,\ 2, \ldots, n \quad t = 2016, ..., 2021), \tag{8}$$

y_{it}, y_{it_0} – share price quotations of i-the company on the last and first day of Warsaw Stock Exchange trading in t-the year.

RESULTS

Analysing both the TMAI and BZW rankings, it can be seen that in all analysed years, companies specializing in the production of interior finishing materials open the presented classifications, while companies producing prefabricated elements and materials for the construction industry tend to close them. The best companies include: Śnieżka S.A., Decora S.A., Ferro S.A and MFO S.A., and the weakest are represented by KBDom S.A., Libet S.A. and delisted Ceramika Nowa Gala S.A. (March 8, 2021) and ES-System S.A. (April 14, 2020).

In the 2016 – 2020 rankings, both delisted companies are in the final positions. Therefore, it was considered that this does not detract from the value of the overall analyses. The fact that the companies were delisted also provides a certain result in the fundamental strength analysis, and for the comparison of the company rankings in 2020 and 2021, the delisted companies can be assumed to occupy the final positions.

Śnieżka S.A. (manufacturer of paints and varnishes) is one of the leaders among all the analysed enterprises. The company owes its success to high profitability ratios: equity – over 20% and sales – over 11%. The return on the company's assets was above 13%, with the level of 2% to 6% required from the lenders' point of view. Among all companies in the sector, Śnieżka S.A. made the best use of its assets, did not involve excessive foreign capital in financing its operations, and achieved optimal, almost textbook values in the turnover of

receivables. However, the average values of annual rates of return place the company in the ninth position.

Table 4. Results of the TMAI measure of the studied companies for years 2016-2021

COMPANY	2021		2020		2019		2018		2017		2016		Average
Ceramika Nowa Gala S.A.	*	*	0.306	↑ 14	0.000	↓ 17	0.075	↓ 16	0.588	↑ 13	0.081	↓ 16	0.210
Decora S.A.	0.580	↓ 2	0.611	↑ 1	0.644	↑ 4	0.483	↑ 5	0.652	↓ 8	0.461	↑ 5	0.572
ES-System S.A.	*	*	*	*	0.608	↑ 10	0.319	↑ 14	0.562	15	0.222	↓ 14	0.428
Ferro	0.557	3	0.536	↑ 3	0.639	↓ 5	0.536	2	0.698	↑ 2	0.536	↑ 3	0.584
FFiL Śnieżka S.A.	0.473	↓ 4	0.552	↓ 2	0.672	1	0.557	1	0.701	↑ 1	0.618	↓ 2	0.595
Izolacja-Jarocin S.A.	0.344	↓ 13	0.385	↑ 10	0.594	↓ 13	0.413	↓ 9	0.654	↑ 7	0.326	11	0.453
Izostal S.A.	0.352	↑ 12	0.323	↓ 13	0.627	↑ 7	0.411	↓ 10	0.684	↑ 5	0.366	↑ 9	0.461
Korporacja Budowlana Dom S.A.	0.157	↑ 15	0.173	↓ 16	0.509	↓ 16	0.085	↑ 15	0.294	↓ 17	0.154	↓ 15	0.125
Lena Lighting S.A.	0.363	↓ 11	0.417	↑ 8	0.530	↓ 15	0.320	↑ 13	0.560	↑ 16	0.000	↓ 17	0.365
Lentex S.A.	0.383	↑ 8	0.416	↑ 9	0.567	↓ 14	0.411	↓ 11	0.619	↓ 10	0.526	↓ 4	0.487
Libet S.A.	0.165	↑ 14	0.212	↓ 15	0.619	↑ 9	0.000	↓ 17	0.579	14	0.233	↓ 13	0.301
Mercor S.A.	0.469	↑ 5	0.449	6	0.635	↑ 6	0.460	↓ 7	0.670	↑ 6	0.357	↓ 10	0.507
MFO S.A.	0.647	↑ 1	0.448	↓ 7	0.654	↑ 2	0.523	↑ 3	0.691	↓ 4	0.630	↑ 1	0.599
Pozbud T&R S.A.	0.421	↓ 7	0.450	↑ 5	0.606	↑ 11	0.391	↓ 12	0.634	↓ 9	0.382	↓ 8	0.481
Ropczyce S.A.	0.371	↑ 9	0.356	↑ 11	0.598	↓ 12	0.471	↑ 6	0.608	↓ 11	0.391	↓ 7	0.466
Selena Fm S.A.	0.469	↓ 6	0.465	↓ 4	0.651	↑ 3	0.431	↓ 8	0.692	↑ 3	0.419	↓ 6	0.521
Ulma Construccion Polska S.A.	0.369	↑ 10	0.340	↓ 12	0.622	↓ 8	0.501	↑ 4	0.588	↑ 12	0.279	↑ 12	0.450

Source: own calculation [* delisting of shares from the stock exchange]

Ferro S.A. (manufacturer of sanitary, installation and heating fittings) focuses on the development of sales through strong expansion and diversification of sales markets and product offer, while continuing to increase operational flexibility and effectively manage supply risk in order to constantly maximize profits and shareholder value. The implementation of this strategy was confirmed by high return on sales – over 13% and growing year by year: return on equity to 30% and return on assets to 18% in 2021. Reasonable use of external capital, proper turnover of receivables and inventories as well as optimal values of the liquidity ratio ensured the company a high position in the TMAI and BZW rankings and a good market rating in the classification of rates of return.

Decora S.A. (manufacturer of floors and floor accessories) in the years 2016-2021 achieved a growing return on sales oscillating from 7% to 17% and a growing return on assets from about 10% to 22%. The increase in the company's turnover to a large extent translated into an increase in profit from sales. In addition, the company was characterized by a low debt ratio, optimal current liquidity values and increasing return on assets, which translated into high positions in the rankings and the highest position in the classification of average rates of return.

MFO S.A. (manufacturer of steel profiles) is a company producing prefabricated elements and products for the construction industry, which occupies

the highest positions in all created rankings. It is present in fifty export markets. In the years 2016-2021, it strongly strengthened the return on sales ratios from 6% to 17%, return on equity from 14% to 31% and return on assets from 9% to 18%. Maintaining optimal liquidity, a relatively low debt ratio and a proper rotation of inventories and receivables allowed for a strong assessment of the company's fundamental strength.

Table 5. Results of the BZW measure of the studied companies for years 2016-2021

COMPANY	2021		2020		2019		2018		2017		2016		Average
Ceramika Nowa Gala S.A.	*	*	0.388	↑ 13	0.213	↓ 17	0.346	↓ 16	0.562	↑ 12	0.280	↑ 15	0.358
Decora S.A.	0.606	↓ 2	0.668	↑ 1	0.679	↑ 4	0.595	↑ 5	0.636	↓ 7	0.512	↑ 6	0.616
ES-System S.A.	*	*	*	*	0.592	↑ 11	0.390	↑ 13	0.485	↑ 16	0.267	↓ 16	0.410
Ferro	0.590	3	0.581	↑ 3	0.668	↓ 5	0.616	3	0.702	3	0.596	3	0.625
FFiL Śnieżka S.A.	0.539	↓ 5	0.605	↓ 2	0.731	1	0.674	1	0.726	1	0.712	1	0.664
Izolacja-Jarocin S.A.	0.412	↓ 11	0.452	↑ 9	0.602	↓ 10	0.532	↓ 9	0.636	↑ 6	0.419	↓ 12	0.509
Izostal S.A.	0.440	↓ 9	0.504	↓ 7	0.665	↓ 6	0.597	↓ 4	0.707	↑ 2	0.532	↑ 5	0.574
Korporacja Budowlana Dom S.A.	0.197	↑ 15	0.214	↓ 16	0.476	↓ 16	0.362	↑ 15	0.309	↓ 17	0.458	↓ 10	0.336
Lena Lighting S.A.	0.395	↓ 13	0.428	↑ 11	0.480	↓ 15	0.373	↑ 14	0.501	↑ 15	0.192	↓ 17	0.395
Lentex S.A.	0.424	10	0.436	↑ 10	0.505	↓ 14	0.482	11	0.582	↓ 11	0.544	↑ 4	0.496
Libet S.A.	0.337	14	0.375	↓ 14	0.618	↑ 9	0.323	↓ 17	0.606	↓ 10	0.459	↓ 9	0.453
Mercor S.A.	0.509	6	0.524	↑ 6	0.628	8	0.554	8	0.628	↑ 8	0.446	↓ 11	0.548
MFO S.A.	0.694	↑ 1	0.545	↓ 5	0.701	2	0.645	↑ 2	0.699	↓ 4	0.686	2	0.662
Pozbud T&R S.A.	0.472	↑ 7	0.504	↑ 8	0.588	12	0.462	↓ 12	0.627	↓ 9	0.503	↓ 7	0.526
Ropczyce S.A.	0.399	↑ 12	0.360	↓ 15	0.557	↓ 13	0.514	↑ 10	0.544	14	0.375	↓ 13	0.458
Selena Fm S.A.	0.545	4	0.557	↓ 4	0.680	↑ 3	0.562	↓ 7	0.680	↑ 5	0.485	↓ 8	0.585
Ulma Construccion Polska S.A.	0.464	↑ 8	0.420	↓ 12	0.638	↓ 7	0.586	↑ 6	0.554	↑ 13	0.341	↑ 14	0.501

Source: own calculation (* delisting of shares from the stock exchange)

Decisive for Selena FM S.A.'s (distributor of construction chemicals) high position in the enterprise rankings was the proper management of the company's assets, as indicated by the receivables, liabilities and inventories turnover ratios. The increase in the value of the asset turnover ratio in 2016-2021 indicated the desired increase in sales per asset unit. Also noteworthy is the growing return on sales in the analysed period, which means that each zloty of the company's revenue resulted in a higher and higher profit**.**

KBDom S.A. is the only company among the surveyed ones that in all surveyed years incurred losses and occupies the last place in the rankings. Until 2012, the company focused a significant part of its business on housing construction, where it suffered extremely high losses. In 2013, the company changed its business profile towards the production of concrete prefabricated elements, which resulted in a temporary improvement in the company's financial results. Analysing the financial statements of this company for the years 2016-2021, it can be concluded that the company had very big problems with paying off its liabilities, which could have been

a consequence of excessive crediting to its own customers and freezing of funds in inventories. This is confirmed by the lowest inventory turnover ratio in the group of surveyed companies and the highest payables turnover ratio, with their untimely repayment. Problems with liquidity and the lack of timely publication of financial statements were the reason for suspending the company's share quotations in 2018, 2019 and 2021. The quotations were permanently suspended on December 1, 2021, and on May 25, 2022, the company was declared bankrupt.

Libet S.A. (manufacturer of paving stones and other concrete elements of the environment arrangement), with low profitability on sales, incurred losses in five years of the analysis (see table 2), which resulted in negative results of indicators based on the financial result and an unfavourable position in the rankings. A high level of debt ratio may suggest that the company has had difficulty repaying its debt. The other surveyed indicators also assume values close to the negative ones. The company explained its problems with the dynamic changes taking place in the macroeconomic environment at the turn of 2018-2019, but the company is constantly trying to rebuild its market and liquidity position. The increase in sales revenues was positively influenced by the company's acquisition of new customers in stable distribution channels and temporary changes in consumer behaviour resulting from the COVID-19 pandemic, especially the increased interest in the company's products during the spring lockdown.

Ceramika Nowa Gala S.A. (former manufacturer of wall and floor tiles, acquired by Cerrad) and ES-System S.A. (manufacturer of lighting fittings, part of the Norwegian Glamox Group since December 2019) recorded low positions in the rankings in the audited years, which were the results of deteriorating profitability ratios, high levels of receivables [freezing of cash] and extended repayment periods. Both companies also felt the negative effects of the situation in Ukraine and Russia, where they exported part of their products.

The convergence of rankings and investment performance of companies was measured with the Spearman's rank correlation coefficient and the significance of the correlation was examined. The values of Spearman's rank correlation coefficients and the results of the verification of hypotheses are presented in Table 7. Based on the obtained results, it can be concluded that the convergence of the rankings constructed on the values of both TMAI and BZW measures is high and statistically significant for all the years studied. Conversely, the correlation between the fundamental strength of the company, as measured using the TMAI, and its investment performance is positive and statistically significant for 2016, 2018 and 2021. Only the BZW measure is negatively correlated with stock market return rank in 2020. For the other years, the correlations BZW with rates of return show the same direction of dependence but are mostly not statistically significant, except for the results for 2018 and 2021.

Table 6. Results of the logarithmic annual rate of return [%] for the years 2016–2021

COMPANY	2021	2020	2019	2018	2017	2016	Average
Ceramika Nowa Gala S.A.	*	26,44	38,57	-129,75	45,59	-2,53	-4,34
Decora S.A.	7,96	48,91	22,12	38,74	7,11	23,53	24,73
ES-System S.A.	*	*	45,86	-21,36	3,52	-9,17	4,71
Ferro	28,67	50,42	13,83	-17,15	33,00	19,56	21,39
FFiL Śnieżka S.A.	-15,94	8,80	5,64	-0,64	21,98	6,57	4,40
Izolacja-Jarocin S.A.	23,80	36,62	-10,92	-15,00	33,55	20,48	14,76
Izostal S.A.	-6,02	-1,50	-7,05	-62,29	-7,03	22,18	-10,28
Korporacja Budowlana Dom S.A.	-48,84	20,31	-35,34	-171,05	-28,09	1,75	-43,54
Lena Lighting S.A.	12,14	10,97	25,13	-58,31	18,10	-6,72	0,22
Lentex S.A.	-16,91	41,60	2,42	-7,80	-26,92	18,72	1,85
Libet S.A.	-25,49	143,12	-77,32	-47,52	36,29	-34,83	-0,96
Mercor S.A.	33,71	16,28	14,44	-31,58	4,01	20,31	9,53
MFO S.A.	63,39	7,19	7,04	-42,65	24,17	78,44	22,93
Pozbud T&R S.A.	53,53	31,14	-26,28	-55,42	19,57	-50,05	-4,59
Ropczyce S.A.	32,87	9,45	-43,70	28,97	24,60	-10,52	6,94
Selena Fm S.A.	26,03	9,59	58,91	-73,37	-11,44	34,48	7,36
Ulma Construccion Polska S.A.	30,60	-13,28	-20,88	-6,11	2,86	-12,42	-3,20

Source: own calculation [* delisting of shares from the stock exchange]

Statistically significant are the correlations between both phenomena, observed for the entire analysis period, both for TMAI and rates of return, as well as BZW and rates of return.

Table 7. Relations between TMAI and BZW and **rates** of **return**

	2021	2020	2019	2018	2017	2016	Average
	Spearman's rank correlation coefficient						
TMAI and BZW	0,9286	0,8853	0,9779	0,9240	0,9375	0,8186	0,9289
t-statistics	9,6896	7,3731	18,1326	9,3599	10,5484	6,6083	9,7162
p-value	7,55E-08	2,32E-06	1,30E-11	1,18E-07	2,46E-08	8,32E-06	7,29E-08
	Spearman's rank correlation coefficient						
TMAI and rofr	0,5143	0,0662	0,2181	0,6324	0,1005	0,5074	0,6863
t-statistics	2,3225	0,2569	0,8657	3,1614	0,3912	2,2802	3,6543
p-value	0,0347	0,8008	0,4003	0,0065	0,7012	0,0376	0,0023
	Spearman's rank correlation coefficient						
BZW and rofr	0,7143	-0,1809	0,1225	0,4951	0,2451	0,2451	0,5784
t-statistics	3,9528	-0,7123	0,4782	2,2070	0,9791	0,9791	2,7463
p-value	0,0013	0,2436	0,6394	0,0433	0,3430	0,3480	0,0150

Source: own calculation

The correctness of the classification of companies producing building materials in the rankings obtained as a result of the application of the TMAI method, verified by an expert analysis of financial statements, is relatively slightly higher than as a result of using the BZW measure. The team of experts assessed the financial

ratios of profitability, liquidity, efficiency and debt, as well as the cash flow statement, and consisted of accountants from listed companies not included in the analysis. The weights used for the financial ratios in the TMAI construction were also reviewed and confirmed. Furthermore, it can be concluded that the TMAI rankings tend to show a slightly stronger correlation with the order of the companies according to their stock market returns than the BZW rankings, which also confirms the effectiveness of this approach.

CONCLUSION

The paper presents the results of rankings built for seventeen companies from the construction materials industry, based on selected nine most important financial indicators describing the condition of enterprises. Taxonomic measures TMAI and BZW, which measure the fundamental strength of companies, were used as a research method. The obtained classifications were compared with the investment results of the surveyed companies, measured by the logarithmic annual rate of return.

The obtained results indicate that in all cases [except one - with BZW measure] the correlation between taxonomic measures and logarithmic rates of return is positive. However, statistically significant relationships between the values of TMAI and BZW and the rates of return on shares of the analysed companies are observed only for the entire study period 2016-2021 and for 2018 and 2021 for current relations.

The statement that the fundamental strength of companies affects their investment performance seems to be confirmed, although the study also shows that there are other factors affecting the rates of return of the shares of the analysed companies. Moreover, for data from individual years, the correlation between the two phenomena is usually not very strong. In addition, a slightly better convergence of the investment efficiency, as measured by the rate of return on shares, with the assessment of the fundamental strength of the companies studied, calculated with the TMAI algorithm, than with the BZW has been demonstrated.

The obtained results are consistent with the research in the works of Juszczyk [2015] and Witkowska, Kuźnik [2019], although it should be taken into account that in the analysis carried out, a different group of enterprises was used for the construction of taxonomic measures, a different time horizon was considered and a slightly different set of variables.

It should be emphasized that synthetic taxonomic measures make it possible to measure the company's fundamental strength and to build rankings of companies with a similar asset structure within the analysed group, from the point of view of assessing the level of financial condition and investment attractiveness of the surveyed companies. The results of the research presented in this article confirm the validity of the use of multidimensional comparative analysis methods in the analysis of the capital markets.

REFERENCES

Bartosiewicz S. (1976) Propozycja metody tworzenia zmiennych syntetycznych. Prace AE we Wrocławiu, 84, 5-7.

Bintara R., Wahyudi R., Molina S. M. (2019) Analysis of Fundamental Factors on Stock Price. International Journal of Academic Research in Accounting, Finance and Management Sciences, 9(4), 169-181.

Cieślak M. (1974) Taksonomiczna procedura prognozowania rozwoju gospodarczego i określenia potrzeb na kadry kwalifikowane. Przegląd Statystyczny, 21(1), 29-39.

Gatnar E., Walesiak M. [red.] (2004) Metody statystycznej analizy wielowymiarowej w badaniach marketingowych. Wydawnictwo Akademii Ekonomicznej im. O. Langego, Wrocław.

Graham B. (2007) Inteligentny inwestor. Wydawnictwo Studio EMKA, Warszawa.

Graham B., Dodd D. (2005) Security Analysis. 5th ed. New York–Toronto–London: Mc Grow-Hill.

Hellwig Z. (1968) Zastosowanie metody taksonomicznej do typologicznego podziału krajów ze względu na poziom rozwoju oraz zasoby i strukturę wykwalifikowanych kadr. Przegląd Statystyczny, 15(4), 307-327.

Jajuga K., Jajuga T. (2000) Inwestycje. Instrumenty finansowe, ryzyko finansowe, inżynieria finansowa. Wydawnictwo Naukowe PWN, Warszawa.

Juszczyk M. (2015) Powiązanie kondycji finansowej spółek giełdowych określonej syntetycznym miernikiem atrakcyjności inwestowania (TMAI) z kształtowaniem się kursów ich akcji. Zeszyty Naukowe Szkoły Głównej Gospodarstwa Wiejskiego, Ekonomika i Organizacja Gospodarki Żywnościowej, 111, 81-95.

Kukuła K. (1986) Propozycja miary zgodności układów porządkowych. Zeszyty Naukowe AE w Krakowie, 22, 81-104.

Kukuła K. (2000) Metoda unitaryzacji zerowanej. Wydawnictwo Naukowe PWN, Warszawa.

Łuniewska M., Tarczyński W. (2006) Metody wielowymiarowej analizy porównawczej na rynku kapitałowym. PWN. Warszawa

Mrzygłód U., Nowak S. (2013) Stock Exchanges Go Public: the Case of Warsaw Stock Exchange. Journal of International Studies, 6(2), 111-123. http://dx.doi.org/10.14254/2071-8330.2013/6-2/10

Muhammad S., Gohar A. (2018) The Relationship Between Fundamental Analysis and Stock Returns Based on the Panel Data Analysis; Evidence from Karachi Stock Exchange (KSE). Research Journal of Finance and Accounting, 9(3), 84-96.

Seng D., Hancock J. R. (2012) Fundamental Analysis and the Prediction of Earnings. International Journal of Business and Management.7(3), 32-46.

Strahl D. (1978) Propozycja konstrukcji miary syntetycznej. Przegląd Statystyczny, 25(2), 205-215.

Tan Y., Wang Z., Xiong H., Liu Y. (2022) Fundamental Momentum and Enhanced Fundamental Momentum: Evidence from the Chinese Stock Market. International Review of Economics & Finance, 79, 680-693.

Tarczyński W. (1994) Taksonomiczna miara atrakcyjności inwestycji w papiery wartościowe. Przegląd Statystyczny, 3, 275-300.

Tarczyński W. (2002) Fundamentalny portfel papierów wartościowych. PWE, Warszawa.

Tarczyński W., Łuniewska M. (2004a) Dywersyfikacja ryzyka na polskim rynku kapitałowym. Placet, Warszawa.

Tarczyński W., Łuniewska M. (2004b) Portfele klasyczne, fundamentalne i zdywersyfikowane poziomo – analiza porównawcza. Acta Universitatis Lodziensis, Folia Oeconomica, 177, 171-189.

Tarczyński W., Łuniewska M. (2005) Stability of Selected Linear Ranking Methods — An Attempt of Evaluation for the Polish Stock Market. [In:] Baier D., Wernecke KD. (eds) Innovations in Classification, Data Science, and Information Systems. Studies in Classification, Data Analysis, and Knowledge Organization. Springer, Berlin, Heidelberg, 523-534.

Tarczyński W., Tarczyńska-Łuniewska M., Tarczyński P. (2017) Scoringowa metoda wyznaczania sektorowego wskaźnika siły fundamentalnej na przykładzie spółek notowanych na Giełdzie Papierów Wartościowych w Warszawie. Finanse. Rynki Finansowe. Ubezpieczenia, 2 (86), 21-31.

Tarczyński W. (2017) Fundamentalny portfel papierów wartościowych jako alternatywa dla modelu Markowitz'a. [In:] Szymańska A. (red.). Ubezpieczenia i finanse. Rozwój i perspektywy. Wydawnictwo Uniwersytetu Łódzkiego, Łódź, 187-198.

Walesiak M. (2003) Uogólniona miara odległości GDM jako syntetyczny miernik rozwoju w metodach porządkowania liniowego. Prace Naukowe Akademii Ekonomicznej im. Oskara Langego we Wrocławiu, nr 988, Jajuga K., Walesiak M [red]. Taksonomia 10, Klasyfikacja i analiza danych – teoria i zastosowania. Wydawnictwo Akademii Ekonomicznej im. Oskara Langego we Wrocławiu, Wrocław, 124-133.

Walesiak M. (2004) Decision Problems in a Cluster Analysis Procedure. Ekonometria, 13, 55-59.

Walesiak M. (2014) Data Normalization in Multivariate Data Analysis. An Overview and Properties. Przegląd Statystyczny, 4, 363-372.

Witkowska D. (2010) Zastosowanie syntetycznych mierników taksonomicznych do pomiaru efektywności chińskich banków. Metody Ilościowe w Badaniach Ekonomicznych, 11(2), 281-292.

Witkowska D., Kuźnik P. (2019) Does Fundamental Strength of the Company Influence its Investment Performance? Dynamic Econometric Models, 19, 85-96.

Zeliaś A., Malina A. (1997) O budowie taksonomicznej miary jakości życia. Syntetyczna miara rozwoju jest narzędziem statystycznej analizy porównawczej. Taksonomia, 4, 238-262.

Zielińska-Sitkiewicz M. (2015) Zastosowanie wybranych mierników syntetycznych do klasyfikacji spółek przemysłu spożywczego notowanych na GPW w Warszawie. Metody Ilościowe w Badaniach Ekonomicznych, 16(4), 271-279.

Zielińska-Sitkiewicz M. (2017) Classification of Selected Food Industry Companies Listed on the Warsaw Stock Exchange - the Impact of Normalization Procedures. Proceedings of the 2017 International Conference "Economic Science for Rural Development" Jelgava, 46, 359-366.