Application of Selected Multidimensional Discriminant Models for Assessing Financial Condition: The Case of Renewable Energy Companies Listed on the NewConnect Market

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Abstract

The article focuses on assessing the financial condition of companies listed on the NewConnect market using selected discriminant models, which are valuable tools for evaluating these enterprises. The main objective of the research was to apply selected Polish discriminant analysis models to study the financial condition of companies listed on the NewConnect market in the renewable energy sector. The purpose of the research was conditioned by the adopted research hypothesis, which stated that companies in the renewable energy sector listed on the NewConnect market were characterized by good and stable financial conditions during the analyzed period. The results confirmed that discriminant analysis models are a valuable tool for assessing the financial condition of the analyzed entities. On the other hand, on the other hand, the research carried out allowed the conclusion that companies operating on the NewConnect market (renewable energy sector) in 2019-2024 were in a diverse and ambiguous financial situation.

Keywords

discriminant analysis, financial condition, NewConnect market, Warsaw Stock Exchange

Introduction

An area that affects all aspects of human life is energy [Akinwale, 2022, p. 470], which particularly affects socioeconomic development [Tzanakis et al., 2011, pp. 462-502]. In addition, energy has applications in every area of social, economic and

environmental life [Tzanakis et al., 2012, pp. 4126-4140]. The use of energy positively influences the development of international trade, drives economic growth, improves the quality of life, and spreads research and technological innovation [Akinwale, 2021, pp. 373-380; Wang and Guo, 2021, pp. 1-10]. Despite the rise in popularity of renewable energy sources (RES), economic growth in many countries remains largely based on conventional fuels [Akinwale, 2018, pp. 601-614].

Further international efforts are needed to achieve climate neutrality by 2050 within the European Union [Jänicke and Wurzel, 2020, pp. 22-42]. It is crucial to educate future leaders on the implementation of climate policy in member states and European Union institutions in the area of RES development [https://www.eea.europa.eu/data-and-maps/indicators/greenhouse-gasemission-trends-7/assessment, 28.11.2025].

The rate of energy regeneration from RES is significantly faster than that from conventional sources [Karasmanaki and Tsantopoulos, 2019, pp. 111-119]. Renewable energy is now a sustainable energy path because it emits no or negligible dangerous gases [Adepoju and Akinwale, 2019, pp. 69-82]. Renewable energy can include: hydroelectric, solar, wind, biomass, geothermal, bioenergy, and wave and tidal energy [Jamil et al., 2012, pp. 266-274; Pan et al., 2019, pp. 456-464; Balcerzak et al., 2024, pp. 379-390]. In connection with the key aspect of renewable energy development, it seems appropriate to analyze the evolution of entities operating in this field.

The subject of the research is the NewConnect market, with a particular focus on companies in the "renewable energy" sector. The NewConnect market on the Warsaw Stock Exchange began in August 2007. This market is geared towards the development of small and medium-sized companies with high growth potential. The NewConnect market is aimed at investors who accept higher risk and hope for potentially high returns [https://newconnect.pl/o-rynku, 28.11.2025]. As of November 2025, there were 356 companies on this market (355 domestic and one foreign) with a total capitalization of PLN 13,052.65 million [https://newconnect.pl/statystyki-okresowe, 28.11.2025].

The financial condition of a company is also referred to as "financial standing". W. Bien treats the financial standing of an enterprise as "*a company's competitive position in the market, its credibility and economic strength*" [Bien, 1999, p. 81]. In addition, the financial position of a company is referred to in the literature as "financial health" [Wypych, 1998, pp. 177-178; Smithson et al., 2000, p. 167]. To assess an entity's financial condition, one can use the so-called multidimensional analysis, which focuses on quantitative factors. A limiting factor affecting the effectiveness

of discriminant analysis models is that it omits a crucial area of the company's operations: industry specificity [Rusek, 2010, p. 56; Wysocki and Kozera, 2012, p. 182]. In addition, the use of multidimensional discriminant analysis is used to assess the solvency of the companies under study. This can help identify early symptoms of insolvency risk leading to bankruptcy [Antczak, 2023]. Because discriminant analysis models may lose value over time, their effectiveness is assessed using the latest financial data [Pilch, 2021].

In the era of the capitalist economy, companies are constantly exposed to various threats, especially in a fluctuating market environment. These threats can create crisis situations in enterprises, leading to bankruptcy. A wide range of stakeholders interested in the financial situation of an enterprise creates a constant need to assess the financial standing of business entities. The mentioned stakeholders can be: banks (providers of external capital), auditors and chartered accountants, rating institutions, and potential investors (individual, institutional) [Zarzecki, 2000, pp. 371-372; Nowicki, 2020, p. 119].

Currently, discriminant analysis, logit models, neural networks, and classification trees remain the primary tools for bankruptcy prediction [Pociecha, 2014]. However, foreign models of discriminant analysis (such as the Altman model) are not practically applicable to the analysis and evaluation of the financial condition of Polish companies. This is related to the dynamic political and economic changes that occurred in Poland during the period of economic transition [Ptak-Chmielewska, 2014, pp. 9-21]. As a result, numerous Polish discriminant analysis models have been developed to predict the bankruptcy of Polish companies and are tailored to the Polish economic reality. The most popular examples of Polish discriminant analysis models may be: S. Gajdka and D. Stos [Gajdka and Stos, 1996], D. Wierzba [Wierzba, 2000, 79-105], A. Hołda [Hołda, 2001, pp. 306-310], M. Gruszczyński [Gruszczyński , 2003], the so-called "Poznań" model of M. Hamrol, B. Czajka and M. Piechocki [Hamrol et al., 2004, pp. 37-48], B. Prusak [Prusak, 2005] or E. Mączyńska and M. Zawadzki [Mączyńska and Zawadzki, 2006, pp. 205-235].

Discriminant analysis is widely used for predicting bankruptcy and assessing a company's financial situation due to its advantages. Nevertheless, like other bankruptcy assessment models, it has its disadvantages. The main advantages of discriminant analysis include, for example, the models juxtapose typical ratio analysis with econometrics [Wojcicka, 2010, p. 116] and reduce the assessment of the financial condition of the analyzed entity to a single numerical value, thus eliminating interpretational discrepancies [Bombiak, 2010, p. 145] or the fact that discriminant analysis models make it possible to assign the evaluated company to a group of com-

panies either at risk or not at risk of bankruptcy. Disadvantages of discriminant analysis include the rapid loss of model usefulness due to changes in economic conditions, and the fact that models are not among the so-called "universal" models. This means they are mainly used in the analysis of manufacturing companies [Kuciński, 2011, p. 160].

The discriminant analysis method is used to study the differentiation of the analyzed entities based on the results of the Z function. Based on the results, the studied entity can be assigned to a group with good or poor financial condition [Stanisz, 2007, p. 51]. Discriminant analysis is part of multivariate statistical analysis, which addresses the problem of discriminating and classifying multidimensional sets [Jajuga, 1993, p. 133]. Discriminant analysis models include a synthetic index, which is a combination of indicators and weights that captures the essence of these indicators and reflects the company's financial situation [Antonovich, 2007; Antonovich, 2010, pp. 3467-476].

The use of selected Polish discriminant analysis models to study the financial condition of companies listed on the NewConnect market in the renewable energy sector was adopted as the main objective of the study. The objective is to assess the financial condition of the indicated companies from the perspective of bankruptcy risk. The research hypothesis (H1) was adopted, stating that companies in the renewable energy sector listed on the NewConnect market were characterized by good and stable financial conditions during the analyzed period.

The first part of the article describes the NewConnect market on the Warsaw Stock Exchange. In the second part, a synthetic literature review of research on the use of discriminant analysis on NewConnect market companies was made. The next part of the article describes selected discriminant analysis models and presents the data and research methodology, respectively. The fourth part contains the results of the estimated models and compares them with results from the literature. The article closes with the fifth part, which includes conclusions.

1. Literature review

The beginning of the 20th century saw a surge of interest in bankruptcy forecasting in the economic literature. One particular event that drew attention to mass corporate bankruptcy was the Wall Street crisis of the late 1920s and early 1930s. [Mączyńska nd Zawadzki, 2006, pp. 205-235]. Edward Altman's 1968 work represents a breakthrough in the development of bankruptcy prediction methods using discriminant analysis [Altman, 1968, pp. 589-609]. Subsequent methods were logit and probit models (1970s and 1980s), which were popularized by Ohlson [1980, pp.

109-131] and Zmijewski [1984, pp. 59-82]. Survival and duration models, on the other hand, were popularized by Shumway [2001, pp. 101-124].

The diversity of research and results in the foreign literature on the subject necessitates further research to assess the financial condition of companies in the renewable energy sector on the Warsaw Stock Exchange. The current literature indicates the popularity of applying multidimensional discriminant analysis models to assess the financial condition of the studied entities. The studies presented in Table 1 analyze and evaluate various entities and the research period. In addition, they were conducted using a diverse set of discriminant analysis models.

Tab. 1. Overview of studies involving the application of multidimensional discriminant analysis to the evaluation of companies in the NewConnect market in Poland

Author	Year	Entities	Time range	Included models of multidimensional discriminant analysis
Kuciński A. [2011].	2011	17 companies from the construction and commercial sectors	2008-2009	- S. Gajdka and D. Stos model - D. Hadasik model - A. Hołda
Nowicki T. [2020, p. 119].	2020	14 entities that filed for bankruptcy in the period: beginning 2018 - February 2020	early 2018 - February 2020	- E. Mączyńska model - S. Gajdka and D. Stos model - D. Hadasik model - D. Wierzba model - "Poznań" model
Postek Ł, Thor M. [2020, pp. 109-137].	2020	More than 400 companies	2014-2016	- S. Gajdka and D. Stos model - D. Wierzba model - A. Hołda - M. Gryszczyński's model - "Poznań" model - B. Prusak - E. Mączyńska and M. Zawadzki model

Source: own study based on a literature search.

The main objective of the research conducted by Kuciński [2011] was to apply selected discriminant models to analyze and evaluate the financial condition of companies listed on the NewConnect market of the Warsaw Stock Exchange. This constituted an attempt to analyze their financial condition and assess the threat of their

bankruptcy. During the study, 31 companies from the construction and trading sectors of the NewConnect market were selected. In the end, the research sample consisted of 17 companies. This was due to their short existence on the indicated market and the incompleteness of financial data. An extension of the research using discriminant analysis models was the analysis and evaluation of stock returns. In this respect, the NewConnect market is considered challenging. The results obtained by Kuciński showed that the analyzed companies achieved negative returns. This indicates that they were not in the best financial condition during the period under review. The reason for this may have been growing financial difficulties.

The research by Nowicki [2020] aimed to evaluate the effectiveness of selected Polish discriminant analysis models. In the research process, five models were selected, and 14 companies listed on the NewConnect market were analyzed. The companies selected for the study were those that had filed for bankruptcy in the last two years (from the beginning of 2018 to the end of February 2020). The values of the individual discriminant analysis models were calculated two years before the bankruptcy filing and one year before this event. In Kuciński's study, the second model of Gajdka and Stos proved to be the most effective of the verified models. However, the indicated model can be very sensitive to classification errors that achieve a positive net result yet are assigned to a group with poor financial condition.

In the research conducted by Postek and Thor [2020], three research objectives were adopted: constructing a bankruptcy prediction model based on companies' financial indicators on the NewConnect market. Another objective was to compare the results obtained from the created model with bankruptcy prediction models for Polish companies reported in the literature. The last objective was to verify the usefulness and feasibility of using discriminant analysis models in constructing an investment portfolio. The period of 2014-2016 was analyzed. In the study, the authors analyzed reports prepared in accordance with three standards: PAS (Polish Accounting Standard, about 87% of reports), IFRS (International Financial Reporting Standard, 13% of reports), and other accounting standards (less than 0.5%). The research sample consisted of 410 companies in 2014 and 406 in 2015 that operated on the NewConnect market.

2. Methodology

The research process of the proposed study firstly consisted of a literature search. In addition, an analysis of the financial statements of the companies under study was conducted during the period under review. In the next stage, appropriate statistical methods were selected. The selection of entities for the study was selective and

concerned entities in the renewable energy sector from the Warsaw Stock Exchange, which operated on the NewConnect market in 2019-2024 (t = 1,2,...,6). The indicated time period included a number of turbulent international geopolitical events that could affect the proper operation of renewable energy companies. These included the Covid-19 pandemic, BREXIT or the war in Ukraine. The following companies were analyzed: Beein Joint Stock Company (BEE), Biomass Energy Project Joint Stock Company (BEP), Corey Europe Joint Stock Company (COR), Elq Joint Stock Company (ELQ), Farmy Fotowoltaiki Polska Joint Stock Company (FFP), Foto Volt Eko Energia Joint Stock Company (FVE), Global Hydrogen Joint Stock Company (GHY), Hipower Energy Joint Stock Company (HPE), Hyenergy Joint Stock Company (HEN), Military Group Joint Stock Company (MIG), Oze Capital Joint Stock Company (OZE), Saule Technologies Joint Stock Company (SLT), Solar Innovation Joint Stock Company (SIN), T&T Proenergy Joint Stock Company (TNT), Voolt Joint Stock Company (VLT) And Zeneris Projects Joint Stock Company (ZEN). While completing the data, some difficulties were encountered due to missing required financial data for some companies. In such a case, it was impossible to determine the values of discriminant functions for all entities in the "renewable energy" sector from the NewConnect market in 2019-2024. This has limited the analysis in some areas, making it difficult to formulate final conclusions.

Four models of discriminant analysis were selected to evaluate the financial condition of the analyzed companies: the D. Hadasik model, the Z6 and Z7 models of INE PAN (E. Mączyńska and M. Zawadzki) and the "Poznań" model (M. Hamrol, B. Czajka, M. Piechocki). The value of the discriminant function Z (in the case of each model) made it possible to classify a given company into a group with good or bad financial condition. Table 2 presents the characteristics of the discriminant analysis models selected for the study.

Tab. 2. Overview of the discriminant analysis models selected for the study

Model	Formula	Indicators
Hadasik [1998].	$Z_H = 2.362 + 0.365X_1 - 0.765X_2 - 2.404X_3 + 1.590X_4 + 0.002X_5 - 0.012X_6$	X_1- Current assets/current liabilities, X_2 - (current assets - inventories/current liabilities), X_3 - total liabilities/total assets, X_4 - (current assets - current liabilities) /total liabilities, X_5 - accounts receivable/sales revenue, X_6 - inventories/sales revenue.
Poznanski [Hamrol, Czajka, Piechocki, 2004; Kisielińska and	$Z_{POZ} = 3.562X_1 + 1.588X_2 + 4.288X_3 + 6.719X_4 - 2.368$	X_1 - Net financial result/total assets, X_2 - (current assets - inventories) / short-term liabilities,

Model	Formula	Indicators
Waszkowski, 2010, pp. 17-31].		X_3 - fixed capital/total assets, X_4 - financial result from sales/revenue from sales.
Z7 INE PAN (Mączyńska, 2004)	$Z_{7INE\ PAN} = 9.498X_1 + 3.566X_2 + 2.903X_3 + 0.452X_4 - 1.4987$	X_1 - operating result/value of assets, X_2 -value of equity/value of assets, X_3 - (net financial result + depreciation) /total liabilities, X_4- current assets/current liabilities.
Z6 INE PAN [Mączyńska, 2004; Mączyńska and Zawadzki, 2006, pp. 205-235].	$Z_{6INE\ PAN} = 9.478X_1 + 3.613X_2 + 3.246AX_3 + 0.455X_4 + 0.802X_5 - 2.478$	X_1 - Operating profit/value of assets, X_2 - equity/value of assets, X_3 - (net financial result + depreciation) /total liabilities, X_4 - current assets/current liabilities, X_5 - sales revenue/value of assets.

Source: own compilation based on the literature search.

For all models selected for the study, the cut-off values are 0. This means that $Z < 0$ difficult financial situation of the entity and $Z > 0$ good financial situation of the entity.

3. Results

Table 3 shows the values of selected discriminant analysis models of the companies in the "renewable energy" sector selected for the study, operating on the NewConnect market in 2019-2024. Values that were below the cut-off value are marked in gray. In this case, their financial situation could be considered deteriorating.

Tab. 3. Results of selected discriminant analysis models for selected companies on the NewConnect market in 2019-2024

	ZEN	VLT	TNT	SIN	SLT	RES	MIG	HE	HPE	GHY	FVE	FFP	ELQ	COR	BEP	BEE
H_2019	0.14	1.00	0.89	1.26	-0.40	0.13	0.98	1.39	-0.11	2.02	-4.68	-1.70	1.66	1.24	2.85	-1.75
H_2020	0.74	1.22	1.79	1.79	1.04	-2.45	0.79	1.28	1.01	2.14	0.82	-22.86	0.26	-1.70	2.35	3.05
H_2021	1.25	1.25	2.13	0.98	-3.00	-0.42	2.27	1.44	0.17	2.12	3.19	-25.70	0.91	1.07	2.13	2.31
H_2022	0.20	1.18	1.93	-2.47	1.75	0.95	-2.53	1.45	0.60	2.08	3.07	-331.92	0.44	1.01	2.64	2.66
H_2023	-0.91	-6.89	1.74	1.40	1.98	0.83	2.13	0.63	-5.80	1.55	1.43	-9.71	0.72	1.12	3.21	2.56
H_2024	0.65	-43.02	1.93	1.21	1.81	0.77	1.61	1.37	2.11	1.46	2.12	0.28	1.59	1.06	2.97	2.40
POZ_2019	3.39	14.97	15.03	3.95	-92.12	14.46	9.67	-3.28	-80.98	7.65	24.00	-3.71	3.82	-1.61	8.38	21.59
POZ_2020	6.12	10.62	3.29	6.23	18.87	26.25	-1.64	8.62	-18.32	8.83	2.51	-44.67	2.04	12.73	5.79	6.50
POZ_2021	9.97	9.88	4.78	8.04	27.61	16.01	-76.45	9.44	-21.22	8.14	4.55	-71.70	-0.56	4.24	7.34	9.93
POZ_2022	15.93	-1.12	3.29	-38.48	-66.68	-1.49	2.24	9.21	-8.53	4.99	4.97	-580.00	0.78	1.75	5.93	4.07
POZ_2023	20.85	0.51	7.42	-17.96	-132.09	8.25	4.69	-13.65	-80.64	1.03	4.15	-8.11	2.73	3.56	11.08	2.34
POZ_2024	13.27	109.67	4.64	-0.44	-179.64	-3.49	-2.86	9.33	4.92	1.89	5.17	10.01	2.78	1.04	12.13	2.12
Z6_2019	2.20	2.80	-2.63	-2.40	9.18	0.07	-0.68	2.19	-6.53	2.01	-21.70	-36.64	1.29	-1.85	0.50	-1.68
Z6_2020	8.65	5.96	2.38	24.56	55.36	14.96	-4.28	6.89	-0.15	8.51	3.10	-56.60	2.67	4.80	4.04	4.00
Z6_2021	6.67	6.91	4.32	-2.28	-28.94	8.25	-2.32	14.57	-2.49	8.24	10.23	-38.75	0.71	2.10	4.92	9.37
Z6_2022	9.29	-2.71	1.29	-31.32	1.13	-5.35	-2.12	5.50	-2.97	0.48	8.30	-712.61	1.98	1.40	3.33	5.55
Z6_2023	11.34	-6.30	4.22	-4.21	1.73	17.53	5.16	-8.57	-51.88	3.15	4.79	-6.17	5.08	3.42	6.90	2.34
Z6_2024	7.20	-45.90	3.21	0.20	1.70	-7.98	-17.44	4.01	-0.22	-0.08	8.18	11.92	4.07	1.47	8.00	2.34
Z7_2019	1.78	12.73	-37.01	-0.48	-3.81	8.36	6.24	1.08	-3.33	6.52	-225.74	-4.13	3.22	0.94	5.24	5.35
Z7_2020	6.74	5.40	2.41	21.83	52.89	14.17	-4.07	6.32	-0.13	7.00	2.17	-58.99	1.26	4.71	3.87	5.56
Z7_2021	5.44	5.72	4.09	-1.79	-25.43	7.90	-1.42	12.38	-2.46	6.71	8.88	-38.54	-0.26	1.86	4.66	9.52
Z7_2022	7.92	-2.34	1.37	-32.58	1.33	-6.96	-2.65	4.11	-2.99	0.23	5.99	-708.39	1.35	1.23	3.29	6.08
Z7_2023	10.00	-4.37	4.04	-3.87	1.81	5.27	4.38	-8.10	-52.43	3.04	2.99	-6.06	3.86	2.69	6.76	2.07
Z7_2024	6.43	-35.74	3.12	0.20	1.75	-8.06	-18.03	3.86	0.13	0.03	6.34	11.32	2.96	1.36	7.81	2.19

* The table uses abbreviated company names: Beein Joint Stock Company (BEE), Biomass Energy Project Joint Stock Company (BEP), Corey Europe Joint Stock Company (COR), Elq Joint Stock Company (ELQ), Farmy Fotowoltaiki Polska Joint Stock Company (FFP), Foto Volt Eko Energia Joint Stock Company (FVE), Global Hydrogen Joint Stock Company (GHY), Hipower Energy Joint Stock Company (HPE), Hyenergy Joint Stock Company (HEN), Military Group Joint Stock Company (MIG), Oze Capital Joint Stock Company (OZE), Saule Technologies Joint Stock Company (SLT), Solar Innovation Joint Stock Company (SIN), T&T Proenergy Joint Stock Company (TNT), Voolt Joint Stock Company (VLT) And Zeneris Projects Joint Stock Company (ZEN).

** H - Dorota Hadasik model, POZ - Poznań model, Z6 - Z6 INE PAN model, Z7 - Z7 INE PAN model.

Source: own study.

As shown in Table 3, across all models, the selected companies achieved values below the cutoff. The only company that achieved values above the cut-off value during the entire period of analysis and under all the models used was BIOMASS Energy Project Joint Stock Company. Very good results were also achieved by the companies: Global Hydrogen Joint Stock Company (only in 2024 - model Z6 negative result) and Zeneris Project Joint Stock Company (only in 2023 - model Hadasik negative result). Equally good results were achieved by the companies: Beein Joint Stock Company (negative result for model H_2019 and Z6_2019), Elq Joint Stock Company (negative result for model POZ_2021 and Z7_2021), and T&T Proenergy Joint Stock Company (negative result for model Z6_2019 and Z7_2019). Equally good results were achieved by the companies: Corey Europe Joint Stock Company (negative result for H_2020, POZ_2019, and Z6_2019) and Foto Volt Eko Energia Joint Stock Company (H_2019, Z6_2019, and Z7_2019). Extremely low values (below the limit of each model used) were achieved by the companies: Farmy Fotowoltaiki Polska Joint Stock Company, Hipower Energy Joint Stock Company, Military Group Joint Stock Company, And Solar Innovation Joint Stock Company. This could indicate their poor or systematically deteriorating financial situation. The reason for such low values in the models selected for the study may have been the negative net profit levels and declining sales revenue during the period of analysis for the indicated companies. Table 4 shows the average values for each model, as well as the rankings based on the discriminant analysis average values for 2019-2024.

Tab. 4. The average values of the discriminant analysis models selected for the study, along with the ranking of the analyzed companies in 2019-2024

Com-pany	MPR - HAD	R - HAD.	ŚR-POZ	R - POZ	R-Z6	R - Z6	R-Z7	R - Z7
BEE	1.87	3	7.76	5 (↓2)	3.65	7 (↓2)	5.13	3 (↑4)
BEP	2.69	1	8.44	4 (↓3)	4.61	3 (↑1)	5.27	2 (↑1)
COR	0.63	10	3.62	9 (↑1)	1.89	11 (↓2)	2.13	8 (↑3)
ELQ	0.93	7	1.93	11 (↓4)	2.63	8 (↑3)	2.07	9 (↓1)
FFP	-65.27	16	-116.36	16 (↕0)	-139.81	16 (↕0)	-134.13	16 (↕0)
FVE	0.99	6	7.56	6 (↕0)	2.15	9 (↓3)	-33.23	15 (↓6)
GHY	1.90	2	5.42	8 (↓6)	3.72	6 (↑2)	3.92	5 (↑1)
HPE	-0.34	14	-34.13	14 (↕0)	-10.71	15 (↓1)	-10.20	14 (↑1)
HE	1.26	5	3.28	10 (↓5)	4.10	5 (↑5)	3.27	7 (↓2)
MIG	0.88	8	-10.72	13 (↓5)	-3.62	13 (↕0)	-2.59	10 (↑3)
RES	-0.03	13	10.00	3 (↑10)	4.58	4 (↓1)	3.45	6 (↓2)
SLT	0.53	11	-70.68	15 (↓4)	6.69	2 (↑13)	4.76	4 (↓2)
SIN	0.69	9	-6.44	12 (↓3)	-2.57	12 (↕0)	-2.78	11 (↑1)
TNT	1.74	4	6.41	7 (↓3)	2.13	10 (↓3)	-3.66	13 (↓3)
VLT	-7.54	15	24.09	1 (↑14)	-6.54	14 (↓13)	-3.10	12 (↑2)

Com-pany	MPR - HAD	R - HAD.	ŚR-POZ	R - POZ	R-Z6	R - Z6	R-Z7	R - Z7
ZEN	0.34	12	11.59	2 (↑10)	7.56	1 (↑1)	6.38	1 (↕0)

* The table uses abbreviated company names: Beein Joint Stock Company (BEE), Biomass Energy Project Joint Stock Company (BEP), Corey Europe Joint Stock Company (COR), Elq Joint Stock Company (ELQ), Farmy Fotowoltaiki Polska Joint Stock Company (FFP), Foto Volt Eko Energia Joint Stock Company (FVE), Global Hydrogen Joint Stock Company (GHY), Hipower Energy Joint Stock Company (HPE), Hyenergy Joint Stock Company (HEN), Military Group Joint Stock Company (MIG), Oze Capital Joint Stock Company (OZE), Saule Technologies Joint Stock Company (SLT), Solar Innovation Joint Stock Company (SIN), T&T Proenergy Joint Stock Company (TNT), Voolt Joint Stock Company (VLT) And Zeneris Projects Joint Stock Company (ZEN).

** (↑1) or (↓1) - increase or decrease in ranking by 1 position compared to the previous year, (↕0) - no change.

*** R- HAD - average values of model D. Hadasik, R - HAD - ranking of D. Hadasik, R-POZ - average values of Poznań model, R - POZ - ranking of Poznań model, R-Z6 - average values of Z6 model, R - Z6 - ranking of Z6 model, R-Z7 - average values of Z6 model, R - Z7 - ranking of Z7 model.

Source: own study.

Based on the results presented in Table 4, it can be concluded that the highest average values within the model D. Hadasik were characterized by the following companies: Biomass Energy Project Joint Stock Company (2.69), Global Hydrogen Joint Stock Company (1.90), and Beein Joint Stock Company (1.87). In contrast, the highest average values in the Poznań model were achieved by: VOOLT JOINT Stock Company (24.09), Zeneris Projekty Joint Stock Company (11.59), And Oze Capital Joint Stock Company (10.00). Zeneris Projects Joint Stock Company ranked first in terms of average values for Z6 INE PAN (7.56) and Z7 INE PAN (6.38). Saule Technologies Joint Stock Company ranked second in the Z6 model (6.69), and Biomass Energy Project Joint Stock Company ranked third (4.61). As for the average values for the Z7 INE PAN models, Biomass Energy Project Joint Stock Company ranked second (5.27) and Beein Joint Stock Company ranked third (5.13).

4. Discussion

The study by Kuciński [2011] used the model of Gajdek and Stack, Hadasik and Hołda, and estimated the values of the discriminant function for 2009 and 2008. The indicated values were determined as the quotient, which is the ratio of the price at the end of a given year to its issue price. The study included 17 companies in the construction and commercial sectors. In addition, the study focused on the analysis and evaluation of stock returns. The results showed that the NewConnect market is

challenging. The vast majority of companies had negative returns, which could indicate less-than-perfect financial condition. The growing financial difficulties of the analyzed companies could be considered as the reason for this. Based on the research in this article, the D. Hadasik model was the least rigorous of the models used.

Nowicki's [2020] study focused on the analysis of 14 entities that filed for bankruptcy from January 2018 to February 2020. Five discriminant analysis models were used for the study. The best model was the Gajdka and Stos model, which achieved up to 92.9% correct classifications one year before filing for bankruptcy (1 misclassified case) and up to 100% correct classifications two years before the company filed for bankruptcy. The analysis showed that all companies considered in the study recorded a net loss two years before bankruptcy. In contrast, only one company recorded a profit one year before filing: Denta-Medical S.A., which was misclassified as the only one by the Gajdka and Stos model. In contrast, D. Hadasik's model achieved 64.3% one year before filing for bankruptcy and 50% two years before filing for bankruptcy. Mączyńska's model showed 64.3% effectiveness one year before filing for bankruptcy and only 28.6% two years before filing. In contrast, the Poznań model achieved 71.4% effectiveness one year before and 50% artificiality two years before filing for bankruptcy. In the research presented in this article, the Poznań model proved to be one of the most rigorous and clearly indicated a deteriorating financial situation for some entities.

Postek and Thor's [2020] research focused on investment issues and on analyzing whether a given company on the NewConnect market can be classified as bankrupt or not using selected discriminant analysis models. More than 400 entities from the indicated market were analyzed, and seven discriminant analysis models were used. Based on the study, most models allow the construction of an investment portfolio whose return exceeds that of a portfolio with equal weights across all companies. The authors noted that the models of Prusak [2005] and Mączyńska and Zawadzki [2006] do not provide this possibility. In addition, according to the Authors, the Poznań [Hamrol et al., 2004] and (in particular) Gruszczyński [2003] models have high investment potential.

Conclusion

An essential issue in the use of discriminant analysis models to assess the financial condition of companies is that diagnostic reliability cannot be equated with the frequency of use in the literature. The research carried out in the article does not confirm the research hypothesis adopted (H1), which stated that companies in the renewable energy sector listed on the NewConnect market were characterized by

good and stable financial conditions during the analyzed period. It should be noted that discriminatory methods should not be attributed to the sector's universality. The research and results presented in the article represent a slice of reality regarding the financial situation of the companies under study. At the same time, the discriminant analysis models correctly classified the companies' financial situation for 2019-2024. With some advance notice, the discriminant analysis models can provide information about the potential and actual problems of the companies under analysis. The research concluded that companies operating on the NewConnect market (renewable energy sector) in 2019-2024 were in a diverse and ambiguous financial situation.

Based on studies by other authors, it can be concluded that the use of multidimensional discriminant analysis is a valuable tool for verifying and evaluating the financial situation of the analyzed companies in the NewConnect market. The different levels of sensitivity and the diverse set of indicators that make up the discriminant analysis models positively affect the evaluation and validity of their use in the proposed study. In the research process, the study was limited to companies from the renewable energy sector (NewConnect market) and the years 2019-2024. Such a narrowed analysis means that further research can be expanded to include entities from another financial market or outside the financial market.

The results presented here demonstrate that the research findings should be approached with great caution. At present, it is very difficult to identify and unequivocally specify a universal model that can be applied to the analysis of any enterprise. The study may indicate the limited usefulness of selected discriminant analysis models for bankruptcy forecasting of companies in the renewable energy sector (including an assessment of their financial situation). It may be incorrect to generalize the results, since the study involved selecting a company for examination and using four discriminant analysis models out of at least a dozen described in the literature.

To some extent, the study fills the research gap regarding the application of multidimensional discriminant analysis to the analysis and evaluation of the financial situation of companies in the NewConnect market. The problems caused by the COVID-19 pandemic remain relevant in renewable energy development, and research in this area must be continued and expanded with further analytical methods. This analysis and publication can contribute to the development of theory and practice in the proposed field of research, which may affect the implementation of public policy.

The results presented in the article do not exhaust the research in the scientific area under discussion. In further research, it would be necessary to expand the analysis to include, for example, indicator analysis (an element of financial analysis) or

investment issues related to the companies' shares (for example, using the Taxonomic Measure of Investment Attractiveness).

Nevertheless, the use of multidimensional discriminant analysis in researching the financial situation of companies in the renewable energy sector is a valuable tool. In addition, the use of this method can help in decision-making when assessing the risk of insolvency for the studied entity and the threat of future bankruptcy.

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Zastosowanie wybranych wielowymiarowych modeli dyskryminacyjnych w ocenie kondycji finansowej na przykładzie spółek z sektora odnawialnych źródeł energii notowanych na rynku NewConnect

Streszczenie

Artykuł koncentruje się na ocenie kondycji finansowej spółek notowanych na rynku NewConnect z wykorzystaniem wybranych modeli dyskryminacyjnych, stanowiących użyteczne narzędzie analizy sytuacji ekonomicznej przedsiębiorstw. Głównym celem badań było zastosowanie wybranych polskich modeli analizy dyskryminacyjnej do oceny kondycji finansowej spółek z sektora odnawialnych źródeł energii notowanych na rynku NewConnect. Cel badania został powiązany z przyjętą hipotezą badawczą, zgodnie z którą przedsiębiorstwa z sektora odnawialnych źródeł energii notowane na rynku NewConnect charakteryzowały się dobrą i stabilną sytuacją finansową w analizowanym okresie. Uzyskane wyniki potwierdziły, że modele analizy dyskryminacyjnej stanowią wartościowe narzędzie oceny kondycji finansowej badanych podmiotów. Jednocześnie przeprowadzone analizy pozwoliły stwierdzić, że spółki działające na rynku NewConnect w sektorze odnawialnych źródeł energii w latach 2019-2024 znajdowały się w zróżnicowanej i niejednoznacznej sytuacji finansowej.

Słowa kluczowe

analiza dyskryminacyjna, kondycja finansowa, rynek NewConnect, Giełda Papierów Wartościowych w Warszawie