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ANALYSIS OF THE BANKRUPTCY PROBABILITY OF SELECTED COMPANIES LISTED ON THE WARSAW STOCK EXCHANGE AND OPERATING IN UKRAINE

Magdalena Kondej https://orcid.org/0000-0002-0806-8857
Institute of Economics and Finance
Warsaw University of Life Sciences – SGGW
e-mail: magdalena_kondej@sggw.edu.pl

Abstract: The aim of the research was to assess the bankruptcy risk of three agribusiness companies listed on the Warsaw Stock Exchange and operating in Ukraine during the 2019-2023 COVID-19 pandemic and war. An Edward Altman discriminant analysis was carried out, along with an analysis of selected financial ratios. The results of the financial analysis of Astarta Holding N.V., KSG Agro S.A., and Ovostar Union N.V. from 2019 to 2023 reveal differing trends.

Keywords: discriminant analysis, corporate bankruptcy prediction models, financial analysis, COVID-19 pandemic

JEL classification: G07, G17

INTRODUCTION

Businesses in Ukraine have been significantly impacted by external factors in recent years, predominantly the COVID-19 pandemic and the ongoing war. The initial invasion of Ukraine by the Russian Federation led to significant inflation in Ukraine, as demonstrated by a 30% reduction in real household income over the subsequent year. Ukraine worked on rebuilding its economy in 2016 and the effort continued until 2020 when the COVID-19 pandemic took precedence over economic recovery. There was an overall economic contraction of 4% tied to the pandemic, undoing much of the relief effort up to that point. Once the pandemic ended and Ukraine began to focus on rebuilding their economy once more, the Russian Federation reaggressed in February 2022 which ushered in a another economic crisis [Petryshyn 2022]. According to the Polish Economic Institute, Ukraine GDP

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declined 29.1% in 2022, while the Kyiv School of Economics estimated Ukraine's losses in fixed assets at at US$143.8 billion. The unemployment rate surged by over 160%, while real wages decreased by 15.8%. The most significant declines in employment were observed in metallurgy, transport, and agriculture. The authors of the publication "Gospodarka wojenna: Ukraina po roku od rosyjskiej inwazji" ("The War Economy: Ukraine One Year After the Russian Invasion") highlighted that Ukraine's fiscal situation was critical. The budget expenditures nearly doubled to 2,705.4 billion hryvnias, with the most substantial increase allocated to the defense sector (rising from 8.6% to 42.2% of the budget). The agricultural sector, which constitutes 14% of Ukraine's GDP, also suffered considerable losses, with cultivated land area shrinking by 30%. Another major challenge for the Ukrainian economy was the sharp rise in inflation, driven primarily by escalating energy costs [Kopiński et al. 2023]. Despite numerous adversities, Ukraine's economy remained resilient, largely due to international financial assistance and its ability to adapt to wartime conditions. According to official data from the European Council, since the onset of Russian aggression in 2022, the European Union and its Member States have provided approximately €135 billion in support to Ukraine and its citizens (as of March 1, 2025).

The ongoing full-scale armed conflict has had a particularly detrimental impact on the food sector, leading to losses caused by land occupation and the blockade of seaports - key export channels [Hamulczuk et al. 2023]. The agricultural sector experienced significant disruptions due to a 30% reduction in available farmland [Petryshyn 2022]. Conducting business under such volatile and unpredictable economic conditions necessitates continuous financial monitoring. The early identification of negative trends enables the implementation of corrective measures, thereby mitigating the risk of potential crises. Financial indicators serve as essential tools for controlling and assessing a company's financial health [Kuciński 2023].

However, every corporate decision entails inherent risks, which may lead to financial distress or even bankruptcy. In the current economic context, a bankrupt entity is defined as a company unable to meet its financial obligations on time, with insufficient assets to cover its liabilities, even if it remains operational [Schwartz 2004]. The insolvency of a business has far-reaching consequences for various stakeholders, including owners, employees, and creditors. The ramifications of bankruptcy extend beyond economic losses, encompassing social and psychological consequences as well [Boratyńska 2014].

Bankruptcy prediction remains a key element of corporate financial assessment, relevant for investors, creditors, and managers. Traditional tools, such as Altman's Z-score models, have been widely used since the early 20th century, originating in response to major financial crises [Juszczyk et al. 2014]. While the issue of corporate financial distress has been extensively studied, this paper offers a novel perspective by applying the Altman model to Ukrainian agriholdings amid severe macroeconomic and geopolitical disruptions.

RESEARCH AIM, DATA AND METHODS

The aim of this research was to assess the potential for bankruptcy of three selected companies from the agri-food sector, listed on the Warsaw Stock Exchange and operating in Ukraine. The period of analysis was 2019-2023, the time of the COVID-19 pandemic and the full-scale war in Ukraine.

The paper uses a discriminant analysis tool developed by Edward Altman [2000] for listed companies and analyses selected financial ratios, such as: return on equity, return on assets, return on sales, current and quick liquidity, overall debt and asset turnover ratios.

The Z-score model is one of the most frequently cited studies on discriminant functions in the literature and serves as the foundation for the development of numerous bankruptcy prediction models. It has been widely applied in assessing the financial condition of companies across various industries, including manufacturing, services, publicly listed firms, and financial institutions. Despite the passage of time since its inception, the Z-score model, developed by Edward Altman [1968], remains one of the most extensively referenced models for predicting financial distress and bankruptcy risk. Its proven effectiveness makes it a valuable tool for investors, regulators, and other stakeholders concerned with evaluating corporate financial stability [Rashid et al. 2023]. Over the years, Altman has introduced several variants of the Z-score model, each tailored to the specific characteristics of different types of companies, including:

- Z-Score [1968] – the original model designed for publicly listed manufacturing firms in the United States.
- Z'-Score [1983] – a modified version adapted for privately held manufacturing companies.
- ZETA Score [1977] – a model developed for large corporations to predict insolvency.
- Emerging Market Score (EMS) [2000] – a model designed for companies operating in emerging markets.

The function of the ESM model is shown below:

$$EMS = 3.25 + (6.56 \cdot X_1) + (3.26 \cdot X_2) + (6.72 \cdot X_3) + (1.05 \cdot X_4) \quad (1)$$

where:

$$X_1 = \frac{working\ capital}{total\ assets},$$

$$X2 = \frac{retained\ earning}{total\ assets},$$

$$X3 = \frac{operating\ income}{total\ assets},$$

$$X4 = \frac{book\ value\ of\ equity}{total\ liabilities}.$$

Within the framework of this study, the implementation of the EMS model variant constitutes a theoretically grounded and context-sensitive methodological adjustment, appropriately reflecting the structural characteristics of emerging market economies and the inherent limitations in financial data availability.

The research material consisted of the financial data of three selected listed companies: Astarta Holding N.V., KSG Agro S.A., and Ovostar Union N.V. for the period 2019-2023. Table 1 presents the general characteristics of the companies studied.

Table 1. Characteristics and revenue of the companies under study

Company name	Revenue from sales (in thousand PLN)	Description
Astarta Holding N.V.	516,688	An agro-industrial company operating in the food processing sector. Its core business includes the production and trade of sugar derived from sugar beets.
KSG Agro S.A.	37,208	One of the largest agro-holdings in the Dnipropetrovsk region. The company's primary activities involve land cultivation and the production of agricultural commodities such as corn, wheat, barley, rapeseed, and soybeans. Additionally, KSG Agro specializes in the cultivation and processing of vegetable and fruit products.
Ovostar Union N.V.	115,077	A company engaged in the agri-food sector in Ukraine, focusing on poultry farming, the production of table eggs, and the processing of eggs into liquid and dried products.

Source: own elaboration based on publicly available data

RESULTS

Table 2 presents the calculated values of selected profitability ratios for Astarta Holding N.V., KSG Agro S.A., and Ovostar Union N.V. for the years 2019-2023.

Table 2. The calculated values of the profitability ratios for the companies analysed

Company name	Financial ratios [%]	Years				
		2019	2020	2021	2022	2023
Astarta Holding N.V.	Return on equity	1.56	2.57	27.31	13.14	11.36
KSG Agro S.A.		162.10	15.93	121.92	-16.52	11.56
Ovostar Union N.V.		-15.34	2.50	1.39	10.12	33.16

Company name	Financial ratios [%]	Years				
		2019	2020	2021	2022	2023
Astarta Holding N.V.	Return on total assets	1.56	8.64	22.35	12.81	11.36
KSG Agro S.A.		11.03	6.15	15.13	0.54	-3.50
Ovostar Union N.V.		-12.54	2.95	0.66	8.27	27.74
Astarta Holding N.V.	Return on sales	0.38	2.07	24.93	12.78	10
KSG Agro S.A.		17	6	58	-10	-6
Ovostar Union N.V.		17.27	5.96	57.59	-10.38	-6.18

Source: own research based on data from the financial statements of selected companies, obtained from the Emerging Markets Information Service (EMIS) database for the years 2019–2023

The return on equity (ROE) ratio measures the amount of net profit generated per unit of equity. The optimal value should be positive and significantly above zero, indicating effective capital utilization. In the case of Astarta Holding N.V., ROE remained positive throughout the analysed period, peaking at 27.31% in 2021. However, following this period, the ratio began to decline, largely due to the escalation of the armed conflict. The performance of KSG Agro S.A. was characterized by considerable volatility. While the company achieved exceptionally high ROE values in 2019 (162.10%) and 2020 (121.92%), a sharp decline in 2022 resulted in a negative value of -16.52%. This downturn was primarily driven by a decrease in net profit and a reduction in equity. Ovostar Union N.V., which reported a negative ROE of -15.34% in 2019, demonstrated a consistent upward trend in subsequent years, ultimately reaching 33.16% in 2023, suggesting a significant improvement in financial performance.

The return on assets (ROA) ratio assesses the efficiency of asset utilization in generating net profit. A positive value indicates the profitability of a company's operations. Astarta Holding N.V. maintained positive ROA values throughout the analyzed period, reaching its highest level in 2021, which reflects effective asset management and an increase in total assets. Conversely, KSG Agro S.A. exhibited a downward trend in ROA, which should be interpreted negatively. After relatively strong results in 2019–2020, the company recorded a negative value of -3.50% in 2023, suggesting operational inefficiencies and declining asset utilization effectiveness. A particularly notable positive development was observed in Ovostar Union N.V., where ROA improved significantly from -12.54% in 2019 to 27.74% in 2023, indicating enhanced operational efficiency.

The return on sales (ROS) ratio measures the amount of operating profit generated per unit of net sales revenue. A positive value signifies an efficient

operational structure. The declining ROS for Ovostar Union N.V. and KSG Agro S.A. should be viewed as a negative indicator, as both companies reported negative values starting in 2022, largely due to a significant drop in operating profits. In contrast, Astarta Holding N.V. experienced an upward trend in ROS until 2021, reaching 24.93%, before declining to 10% in 2023. Despite this decrease, the ratio remained positive throughout the analysed period, indicating the company's stable operational performance.

Table 3 provides an overview of the selected financial liquidity indicators computed for Astarta Holding N.V., KSG Agro S.A., and Ovostar Union N.V. over the period from 2019 to 2023. The presented data offer insights into the liquidity positions of these companies, enabling a comparative analysis of their financial stability and short-term solvency across the analysed years.

Table 3. The calculated values of the liquidity ratios for the companies analysed

Company name	Financial ratios	Years				
		2019	2020	2021	2022	2023
Astarta Holding N.V.	Current liquidity	1.40	3.21	4.44	3.38	4.44
KSG Agro S.A.		0.70	0.75	1.16	0.62	0.60
Ovostar Union N.V.		2.59	2.01	2.09	3.52	6.86
Astarta Holding N.V.	Quick liquidity	0.45	1.44	1.52	1.23	1.42
KSG Agro S.A.		0.27	0.43	0.61	0.32	0.31
Ovostar Union N.V.		1.98	1.39	1.54	2.86	5.97

Source: own research based on data from the financial statements of selected companies, obtained from the Emerging Markets Information Service (EMIS) database for the years 2019–2023

The current liquidity ratio indicates the company's ability to repay its short-term liabilities using current assets. The optimal value of this ratio ranges from 1.2 to 2.0. Astarta Holding N.V., in the years 2020-2023, exhibited ratio values well above the optimal range (3.21-4.44). An excessively high value of the indicator may suggest cash hoarding and the maintenance of a high level of receivables, which could indicate a lack of new investments in the company. Such a situation may have resulted from the uncertain future of the company, operating in a war-affected country. Similarly, the increase in the value of current liquidity ratios (from 2.59 in 2019 to 6.86 in 2023) at Ovostar Union N.V. may have been a precautionary response to the unstable political situation in Ukraine. In contrast, KSG Agro S.A., which recorded below-optimal values of the indicator in the years under review,

should be assessed negatively. This was primarily due to a significant increase in short-term liabilities accompanied by a decrease in current assets.

The quick liquidity ratio measures the extent to which short-term liabilities are covered by highly liquid assets. The optimal value of this ratio is 1.0. Astarta Holding N.V. has maintained values of this ratio higher than the recommended level since 2020. Similarly, Ovostar Union N.V. has shown significantly higher values of the indicator. A ratio value above the optimal level means that the company can quickly cover its current liabilities. In contrast, the values of the quick ratio for KSG Agro S.A., ranging from 0.27 to 0.61, should be assessed negatively. The low value of the ratio indicates a significant decrease in the company's cash reserves. Companies with elevated liquidity ratios likely prioritized maintaining financial buffers to mitigate uncertainty, whereas firms with constrained liquidity faced heightened vulnerability to short-term financial shocks.

Another financial indicator analysed was the asset turnover ratio. The calculated values are presented in Table 4.

Table 4. The calculated values of the asset turnover ratios for the companies analysed

Company name	Years				
	2019	2020	2021	2022	2023
Astarta Holding N.V.	0.59	0.81	0.71	0.72	0.87
KSG Agro S.A.	0.32	0.34	0.69	0.46	0.59
Ovostar Union N.V.	0.72	0.75	0.95	1.23	1.14

Source: own research based on data from the financial statements of selected companies, obtained from the Emerging Markets Information Service (EMIS) database for the years 2019–2023

The asset turnover ratio measures a company's ability to generate sales revenue from its assets. The increase in the ratio for Astarta Holding N.V. (from 0.59 in 2019 to 0.81 in 2020, and then ranging from 0.71 to 0.87 in 2021-2023) and Ovostar Union N.V. should be viewed positively, as it reflects an increase in sales revenue. KSG Agro S.A. achieved the highest value of the ratio in 2021 (0.69). A higher total asset turnover ratio indicates better efficiency in managing the company's assets. This upward trend may be linked to the relatively lean asset structures and export-oriented business models of Astarta and Ovostar, which allowed for more efficient utilization of resources despite external disruptions.

Furthermore, the operational resilience of Astarta and Ovostar can be attributed to their more diversified product structures and relatively advanced logistical capabilities, which likely mitigated the negative effects of supply chain disruptions. By contrast, KSG Agro's asset utilization may exhibit greater vulnerability to regional disturbances, stemming from its narrower operational scope and less diversified asset allocation.

The last financial indicator analysed in this article was the overall debt ratio. The values of the indicator are presented in Table 5.

Table 5. The calculated values of the overall debt ratios for the companies analysed

Company Name	Years				
	2019	2020	2021	2022	2023
Astarta Holding N.V.	0.45	0.40	0.30	0.33	0.28
KSG Agro S.A.	0.89	0.87	0.77	0.80	1.26
Ovostar Union N.V.	0.15	0.18	0.21	0.24	0.12

Source: own research based on data from the financial statements of selected companies, obtained from the Emerging Markets Information Service (EMIS) database for the years 2019–2023

The overall debt ratio indicates the extent to which a company's assets are financed by external capital, i.e., the share of creditors in financing total assets. The optimal value of the ratio should fall within the range of 0.57-0.67. From 2019 to 2023, the ratio values for KSG Agro S.A. were significantly higher than the recommended range, indicating a high financial risk related to the potential loss of the company's ability to repay its debt (i.e., to make timely payments of liabilities) during the analysed period. On a positive note, Astarta Holding N.V. saw a decrease in its total debt ratio from 0.45 in 2019 to 0.30 in 2021, followed by a further decrease to 0.28 in 2023, compared to 0.33 in 2022. This decline is primarily due to a reduction in the company's total liabilities. The overall debt ratio for Ovostar Union N.V. remained below the optimal range throughout the period under review.

These differences may stem from varying capital structures and financing strategies: while Astarta and Ovostar appear to rely more heavily on internal financing and reinvested earnings, KSG Agro's elevated debt levels may reflect greater exposure to short-term borrowing, compounded by limited external equity access and weaker operational cash flows amid geopolitical instability.

Table 6 shows the calculated EMS Score values for the three companies analysed. The colours used in the table correspond to the levels of bankruptcy risk. Dark grey indicates the company's risk of bankruptcy, while light grey indicates the safe zone.

Table 6. Comparison of EMS Score Values for Three Selected Companies

Company name	Years				
	2019	2020	2021	2022	2023
Astarta Holding N.V.	7.63	11.04	12.97	12.50	13.02
KSG Agro S.A.	0.77	1.00	4.65	-2.60	-2.08
Ovostar Union N.V.	13.80	13.59	12.90	15.76	23.83

Source: own research based on data from the financial statements of selected companies, obtained from the Emerging Markets Information Service (EMIS) database for the years 2019–2023

The analysis of the EMS Score function revealed that Astarta Holding N.V. exhibited a positive growth trend. The value of the calculated function in 2019 increased by more than 5 points (from 7.63 to 13.02). The value obtained in 2023

indicated an improvement in the company's financial stability and a low risk of bankruptcy in the near future. In contrast, the values for KSG Agro S.A. showed a concerning decline (from 4.65 in 2021 to -2.08 in 2023). This result pointed to serious financial problems and an increased risk of bankruptcy. From 2022 onwards, KSG Agro S.A. was in the 'danger zone'. Based on the results shown in Figure 1 above, it is evident that Ovostar Union N.V. experienced an increase in its EMS Score, reaching a value of 23.83 in 2023. This indicates the company's stable financial health. Ovostar Union N.V. remained in the 'safety zone', with results suggesting high financial stability and a low risk of bankruptcy.

These results align with the broader financial indicators analysed, confirming the divergent financial trajectories of the firms. The improvement in EMS Score for Astarta Holding N.V. and Ovostar Union N.V. corresponds with their positive profitability and liquidity trends, while the decline observed for KSG Agro S.A. reflects its deteriorating financial condition and heightened bankruptcy risk. This coherence strengthens the validity of the EMS Score as a diagnostic tool within the context of the study.

SUMMARY

The financial analysis of Astarta Holding N.V., KSG Agro S.A., and Ovostar Union N.V. from 2019 to 2023 reveals differing trends. Astarta Holding N.V. showed strong performance with positive ROE, ROA, and ROS, though liquidity ratios were above optimal levels, possibly due to cautious financial management amid political instability. Its EMS Score improved, indicating strong financial stability and low bankruptcy risk. KSG Agro S.A. had high ROE in 2019-2020 but saw a sharp decline in 2022-2023, with negative ROE and declining ROA, signaling operational inefficiencies. Its liquidity ratios and high debt ratios indicated financial stress, and its EMS Score dropped significantly, signaling increased bankruptcy risk. Ovostar Union N.V. demonstrated improved financial performance, with a strong upward trend in ROE and ROA. Despite increased liquidity ratios, it maintained a safe debt level and saw its EMS Score rise, reflecting high financial stability and low bankruptcy risk.

Variations in liquidity ratios can be attributed to firm-specific factors such as capital structure, export dependence, and geographic diversification. Companies with stronger equity positions and international exposure were better equipped to accumulate liquid assets, while firms with limited financial flexibility faced greater liquidity constraints under geopolitical and economic stress.

In summary, Astarta Holding N.V. and Ovostar Union N.V. demonstrated relatively strong financial performance, with effective asset management and solid liquidity, while KSG Agro S.A. faced significant challenges in maintaining profitability, managing debt, and ensuring liquidity, ultimately indicating a higher risk of financial distress. The results emphasize the critical role of robust capital structures and diversified export activities in enhancing corporate resilience during

periods of systemic crisis. The marked disparities in financial performance among the firms studied further illustrate the necessity for dynamic and context-sensitive financial management approaches, especially amid sustained geopolitical instability.

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