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POLISH AUTOMOTIVE INDUSTRY DURING THE COVID-19 PANDEMIC. EVALUATION OF THE WIG AUTOMOTIVE INDEX

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Purpose: The article aims to analyse and evaluate the financial standing of WIG Automotive companies listed on the Warsaw Stock Exchange between 2019 and 2023 using selected discriminant analysis models. We also examined the relationship between liquidity and profitability. The selected time interval supports conclusions about the effects of the COVID-19 pandemic.
Design/methodology/approach: The research process is threefold. It involves a literature review, analysis of 2019-2023 financial data from financial statements of the investigated companies, and selected statistical methods, such as discriminant analysis.
Findings: All the automotive companies were in a good or very good financial standing during the period of interest. We confirmed the practicality of discriminant analysis models for forecasting insolvency risk and evaluating corporate financial standing in stable and unstable business environments. No clear association was identified between liquidity and profitability for the investigated companies.
Practical implications: The presented research can be used to draw the attention of enterprises operating in the automotive industry to methods of assessing their financial condition and verifying the relationships between selected financial indicators.
Originality/value: This article presents an analysis and assessment of the financial condition of selected companies from the WIG Automotive index. Pearson linear correlation analysis was used to identify the underlying causes of these financial results.
Keywords: financial standing, discriminant analysis, WIG Automotive index, Warsaw Stock Exchange, COVID-19 pandemic.
Category of the paper: research paper.

1. Introduction

Enterprise operations, also of listed companies, are under constant dynamic pressure from internal and external constraints. Black swans, which are surprising events of significant uncertainty and low frequency, crises, and catastrophes of substantial impact, are particularly important (Kisielnicki, 2021, p. 23). They are inherent to economic activity. Black swans can substantially affect the financial health and operational stability of an enterprise. The COVID-19 pandemic was a black swan event.

With 8% of the GDP, the automotive industry is counted among the primary sectors of the global economy (Stawiarska et al., 2021, p. 1; Podgórska et al., 2022, p. 93). The Polish automotive industry has transitioned from simple, low-cost, and labour-intensive production of the communist era (Domański et al., 2008, p. 85) to a strong CEE player, critical for the production of vehicles and automotive parts and assemblies, which was possible thanks to international investments (Stojczew, 2021, p. 69; Domański et al., 2008, p. 89). High quality and innovations elevate the competitiveness and advantage of the Polish automotive industry (Misztalewski, Daniluk, 2018, p. 68).

Today, national markets are very interconnected through economic relations. Disruption of a single link in the supply chain can have serious repercussions for many countries (Łuka, Woźniak, 2012, pp. 33-34). The recent COVID-19 pandemic can be considered a major supply chain shock. It shook the global market, individual national economies, and many organisations (Ivanov, 2020, pp. 141-165). The pandemic has substantially affected the automotive industry as well. Its—mostly adverse—impacts were reported by numerous authors (Stojczew, 2021, p. 67; Musa et al., 2023, p. 727; Jureczka, 2022, p. 9), also in the context of corporate financial standing (Hyży, 2023, p. 51).

Given the dynamic growth of the Polish automotive industry in recent years, it is crucial to monitor factors that may impact it. It is also crucial to verify the financial standing of automotive companies and their risk of insolvency (Boratyńska, Yafremava, 2023, p. 276; Antczak, 2015, p. 279). Discriminant analysis is a method for detecting threats and evaluating organisations' financial standing (Pilch, 2021, p. 78; Wojnar, 2014, p. 220; Antczak, 2015, pp. 279-280). It has been applied to the automotive industry, among other domains (Boratyńska, Yafremava, 2023, p. 276). The advantages of discriminative models include specific outcomes that are easy to interpret unambiguously (Pitera, 2019, pp. 193-204).

The period between 2019 and 2023 was a time of substantial changes in the Polish automotive industry: from dynamic growth to challenges brought on by global crises. Table 1 is an overview of registration and production of passenger cars in Poland in that period (Polski Związek Przemysłu Motoryzacyjnego, 2019-2023).

Table 1.
Passenger cars registered and produced in Poland between 2019 and 2023 (thousand)

Year	Passenger cars registered in Poland	Passenger cars produced in Poland
2019	555.6	434.7
2020	428.3	428
2021	446.6	383.2
2022	419.7	420.1
2023	475	574.6

Source: original work based on PZPM reports.

The automotive industry reached an activity peak in 2019. There were 555.6 thousand new cars registered that year. It was thanks to favourable economic conditions and high demand. The passenger car output reached 434.7 thousand units. Despite a slight momentum loss compared to the previous years, it was still a meaningful result for the Polish industry (Polski Związek Przemysłu Motoryzacyjnego, 2020). The market slumped in 2020 due to the COVID-19 pandemic. The registration volume fell to 428.3 thousand, which was about 22% YoY. On the other hand, car production increased to 428 thousand (Polski Związek Przemysłu Motoryzacyjnego, 2021). The recovery began in 2021, slowly at first. Registrations reached 446.6 thousand, and production, 383.2 thousand. It was 10.5% below the 2020 levels (Polski Związek Przemysłu Motoryzacyjnego, 2022). In 2022, the registration volume declined once more to 419.7 thousand. This time, it was because of component shortages and overall economic uncertainty. Still, output grew to 420.1 thousand cars, which was indicative of the rising exports and greater non-domestic demand (Polski Związek Przemysłu Motoryzacyjnego, 2023). Both values improved significantly in 2023. Registrations grew to 475 thousand, which was 13.2% YoY, with car output reaching its long-time high of 574.6 cars (Polski Związek Przemysłu Motoryzacyjnego, 2024).

The **primary goal** of the article is to analyse and evaluate the financial standing of WIG Automotive companies listed on the Warsaw Stock Exchange between 2019 and 2023 using selected discriminant analysis models. We analysed data for years that facilitate conclusions concerning the COVID-19 pandemic. The secondary objective is to verify the association between liquidity and profitability and identify its direction, if any. It was pursued with a ratio analysis of liquidity and profitability metrics. We also employed the Pearson correlation coefficient. The proposed research hypothesis (**H1**) is that discriminant analysis models adequately reflect corporate financial standing under stable and unstable economic conditions. The second hypothesis (**H2**) proposes an association between liquidity and profitability of the investigated companies over the period of interest.

The originality of this study lies in its analysis and assessment of the financial condition of selected companies from the WIG Automotive index (2019-2023) using five discriminant analysis models. Furthermore, the scope of the study was expanded to include a ratio analysis of the financial liquidity and profitability of the analyzed companies, attempting to determine whether there is a statistically significant relationship between these indicators. Pearson linear correlation analysis was used for this purpose.

2. Literature review

The literature is replete with analyses of the COVID-19 pandemic's implications, undertaken by experts in various fields and disciplines. Such a multidimensional black swan could disrupt multiple sectors and pose a threat to enterprises. On the other hand, the pandemic could be a turning point for various companies and improve their financial standing, depending on their scope of business and characteristics. Regular monitoring and evaluation of the current financial standing are important in this context, as is forecasting its growth (Meluzin et al., 2017, pp. 171-187; Meluzin et al., 2018, pp. 148-169). A flexible approach and adaptability to fluctuating constraints may be considered critical at times like this. The COVID-19 pandemic's impact on the automotive industry has also been investigated (Stojczew, 2021, pp. 64-84; Hyży, 2023, pp. 39-54). Researchers analysed corporate financial standing using diverse discriminant analysis models to determine their risk of insolvency (Peres, Antao, 2017, p. 114; Kliestik et al., 2018, p. 570). The 1990s witnessed the emergence of insolvency forecasting models in Poland, marked by the development of the first national discriminant functions based on linear discriminant analysis (Urban, 2024, p. 43). After a decade, there were over a dozen discriminative models dedicated to the Polish macroeconomic constraints (Tomczak, 2019, p. 98). Table 2 summarises studies that analysed the financial standing of automotive companies using discriminative models among other techniques.

Table 2.
Studies on the financial standing of Polish automotive companies that employed discriminant analysis

Author	Year	Investigated companies	Period	Employed discriminant analysis models
Kitowski	2018	WIG Automotive production and trade companies: - Auto Gaz, - Auto Partner, - Dębica, - Fota, - Groclin, - Inter Cars, - Sanok.	2015	- Hadasik's model 4, - Wierzba's model, - Hołda's model, - Hamrol's model, - Mączyńska's model, - Mączyńska & Zawadzki's model (IE PAS G), - Mączyńska & Zawadzki's model (IE PAS F), - Gajdka & Stos's model 4, - Prusak's model 1, - Prusak's model 2.
Boratyńska, Yafremava	2023	Automotive limited liability companies: - Volkswagen Group Polska, - Hyundai Motor Poland, - Kia Polska, - BMW Vertriebs GmbH, - Ford Polska, - Toyota Central Europe, - Volvo Polska, - Porsche Inter Auto Polska, - Mercedes-Benz Polska, - Renault Polska.	2018-2021	- Hadasik's model, - Wierzba's model, - Hołda's model, - Mączyńska & Zawadzki's model (IE PAS F), - Poznań model, - Prusak's model (P1), - Mączyńska & Zawadzki's model (IE PAS G).

Cont. table 2.

Pitera	2024	Seventy-five enterprises in the Euro-Park Mielec and Euro-Park Wisłosan Tarnobrzeg Special Economic Zones, including automotive companies	2015-2021	- Mączyńska's model, - Jagiełło's model, - Maślanka's model, - Prusak's model (P1), - Herman's model.

Source: original work based on the literature review.

Kitowski (2018) attempted to verify the diagnostic reliability of discriminative models using WIG Automotive companies. He focused on the situations of seven enterprises in 2015. His analysis results demonstrated that two of the seven WIG Automotive companies were at risk of insolvency in 2015. The models (Table 1) evaluated the other five as safe. His conclusions emphasise the importance of considering industry-specific criteria and a volatile economic environment when evaluating a company's financial standing. He also suggested that the mere popularity of a model among researchers should not be identified with its reliability.

Boratyńska and Yafremava (2023) analysed ten automotive companies between 2018 and 2021. Their study aimed to verify the performance of discriminative models in evaluating insolvency risk during the COVID-19 pandemic. They employed selected insolvency prediction models designed in Poland (Table 1). The results were somewhat divergent. Wierzba's model and IE PAS's (Institute of Economics, Polish Academy of Sciences) model F did not identify any risk of insolvency for the companies. On the other hand, the other five models suggested a risk of insolvency from 2018 to 2021. The discrepancy was reflected in the conclusions, where the authors suggested the necessity to apply multiple discriminant analysis models to improve diagnostic reliability. Furthermore, they considered the models to be well-aligned with the dynamic business conditions brought about by the COVID-19 pandemic.

In his study of the financial standing of enterprises in special economic zones in Poland, Pitera (2024) employed discriminative models, logistic regression models, and a creditworthiness assessment model (Table 1). The study period was from 2015 to 2021. None of the investigated companies exhibited poor financial standing between 2015 and 2019. A potential business risk was found only in 2020–2021. Additionally, outcomes of the ratio analysis and modified bank risk scoring were consistent over the investigated periods. The author summarised the overall financial standing of the enterprises as good but clearly affected by the COVID-19 pandemic in 2020 and 2021.

In summary, studies often offer divergent results depending on the discriminant analysis model employed. Therefore, multiple models should be used for improved diagnostic reliability. In general, the financial standing of automotive companies during the period of interest (2015-2021) was good, with a downturn and increased insolvency risk between 2020 and 2021, which could be attributed to the COVID-19 pandemic.

The literature review has identified a research gap in the design and application of models specifically tailored to the automotive industry. According to what was established by conducting a literature review, there are no clear studies relating to the analysis and assessment of the financial condition of companies making up the WIG Automotive index to the extent proposed in this study. This could be a path worth following in future research.

3. Methods

The present study employs such research methods and tools as literature review, analysis of financial data from 2019–2023 financial statements of the companies, and selected statistical methods. We selected four automotive companies listed on the Warsaw Stock Exchange that conduct operations in Poland: AC SA, Auto Partner SA, Inter Cars SA, and Sanok Rubber Company SA. The selection was guided by the following inclusion criteria:

- companies listed on the Warsaw Stock Exchange,
- 2019-2023 financial statement available,
- automotive companies.

The sample consisted of automotive industry enterprises with an established market position in Poland, allowing for the reduction of external influences unrelated to the COVID-19 pandemic and thus enabling a more precise assessment of its impact on corporate performance.

We juxtaposed the financial data to conduct a comparative analysis of the selected automotive companies.

Discriminant analysis can be used to evaluate the risk of insolvency. It involves a proper selection and analysis of a set of financial ratios (such as liquidity, profitability, and debt). This way, a model can be designed for forecasting company insolvency (Boratyńska, Yafremava, 2023, p. 277). E.I. Altman is the pioneer of discriminant analysis research and its application in economics and finance (Altman, 1968, pp. 589-609). The primary role of discriminant analysis is to evaluate the economic and financial standing of companies and identify signs of an increasing risk of insolvency (and financial deterioration) (Wysocki, Kozera, 2012, pp. 167-182). Discriminant analysis is particularly useful in the context of the automotive industry. It can help enterprises that operate in difficult market conditions through early detection of threats, facilitating timely response (Boratyńska, Yafremava, 2023, p. 276).

The study employs five models of multivariate discriminant analysis that are the most common in the literature: the model by D. Hadasik, the IE PAS Z6 and Z7 models by E. Mączyńska and M. Zawadzki, D. Wierzba's model, and the Poznań model by Mirosław Hamrol, Bartłomiej Czajka, and Maciej Piechocki. Each model was verified in terms of its accuracy in the economic and financial evaluation of enterprises. We measured the models' performance with percentages: Hadasik 95.08%, IE PAS Z6 94.2%, IE PAS Z7 93.78%,

Wierzba 94%, and 'Poznań' 93.78% (Żurakowska-Sawa, Hodun, 2012, pp. 165-170). Each model is assigned a value for assessing the financial standing of the enterprise. The value, referred to as the threshold, was defined by the authors of each model. In the case of the selected discriminant analysis models, it is (Hadasik, 1998; Mączyńska, 2004). Table 3 summarises the equations of the discriminant analysis models selected for the analysis.

Table 3.
Polish discriminant analysis models used in the study

Models	Equation	Indicators
Hadasik (1998)	$Z_H = 2.36261 + 0.365425A_1 - 0.765526A_2 - 2.40435A_3 + 1.59079A_4 + 0.00230258A_5 - 0.0127826A_6$	A_1 = current assets / current liabilities, A_2 = (current assets – inventories) / current liabilities, A_3 = total liabilities / total assets, A_4 = (current assets – short-term liabilities) / total liabilities, A_5 = receivables / sales revenues, A_6 = inventory / sales revenue
Poznań (Hamrol, Czajka, Piechocki, 2004)	$Z_{POZ} = 3.562A_1 + 1.588A_2 + 4.288A_3 + 6.719A_4 - 2.368$	A_1 = net financial income or loss / total assets, A_2 = (current assets – inventories) / short-term liabilities, A_3 = capital employed / total assets, A_4 = sales results / sales revenue
Wierzba (2000)	$Z_W = 3.26A_1 + 2.16A_2 + 0.3A_3 + 0.69A_4$	A_1 = (operating profit – depreciation) / total assets, A_2 = (operating profit – depreciation) / product sales, A_3 = current assets / total liabilities, A_4 = working capital / total assets
IE PAS Z6 (Mączyńska, Zawadzki, 2004) (Żurakowska-Sawa, Hodun, 2012)	$Z_{(6\ IE\ PAS)} = 9.478A_1 + 3.613A_2 + 3.246A_3 + 0.455A_4 + 0.802A_5 - 2.478$	A_1 = EBIT / assets, A_2 = equity / assets, A_3 = (net result + depreciation) / total liabilities, A_4 = current assets / short-term liabilities, A_5 = sales income / total assets
IE PAS Z7 (Mączyńska, Zawadzki, 2004) (Żurakowska-Sawa, Hodun, 2012)	$Z_{(7\ IE\ PAS)} = 9.498A_1 + 3.566A_2 + 2.903A_3 + 0.452A_4 - 1.4987$	A_1 = EBIT / assets, A_2 = equity / assets, A_3 = (net result + depreciation) / total liabilities, A_4 = current assets / short-term liabilities

Source: original work based on the literature review.

The selection of models was based on their well-documented high predictive reliability in the literature and their consistency with the operating conditions of Polish enterprises, which was particularly important given that the study focused on firms operating in Poland.

The study additionally analyses the three liquidity ratios and three profitability ratios. The period of interest spans 2019–2023, reflecting the situation of the selected companies during the COVID-19 pandemic and the war in Ukraine.

There are three primary profitability ratios that are central to correct financial analysis. They can evaluate the enterprise's performance in various domains. These are return on assets (ROA), which reflects the enterprise's capacity to generate profits with its resources; return on equity (ROE), which reflects how well owners' contributions are multiplied; and return on sales (ROS), which specifies what part of sales profits are converted into net profit. These indicators

help evaluate whether the operations are profitable and verify the financial performance of the company (Rutkowska-Ziarko, 2015).

The primary liquidity ratios include cash ratio (CR), quick ratio (QR), and current ratio (CR). The literature does not provide explicit values of liquidity ratios. Therefore, it is not possible to determine their universal level (Stickney, 2009; Bragg, 2012). Table 4 summarises the equations for the selected ratios with proposed optimum values (liquidity ratios).

Table 4.
Selected profitability and liquidity ratios

Ratio	Formula	Interpretation
Return on equity (ROE)	$\frac{zysk\ netto}{kapitał\ własny}$	The rate of return on the company's employed equity.
Return on assets (ROA)	$\frac{zysk\ netto}{aktywa\ ogółem}$	The efficiency of a company's use of assets to generate earnings.
Return on sales (ROS)	$\frac{zysk\ netto}{sprzedaż\ netto}$	Profit derived from sales.
Cash ratio ($C_{SH}R$)	$\frac{aktywa\ obrotowe\ -\ zapasy\ -\ krótkoterminowe\ rozliczenia\ międzyokresowe\ -\ należności\ krótkoterminowe}{zobowiązania\ krótkoterminowe}$	Optimum value: 0.2 (Soliwoda, 2011)
Quick ratio (QR)	$\frac{aktywa\ obrotowe - zapasy - krótkoterminowe\ rozliczenia\ międyokresowe}{zobowiązania\ krótkoterminowe}$	Optimum value: 1.0-1.2 (Dresler, Czekaj, 2008)
Current ratio (CR)	$\frac{aktywa\ obrotowe}{zobowiązania\ krótkoterminowe}$	Optimum value: 1.5-2.0 (Soliwoda, 2011)

Source: original work based on: Bragg, 2012; Kuciński, 2023; Subramanyam, 2014; Mao, 2023; Akyüz, Bilgiç, 2016; Higgins, 2012; Golas, Witczyk, 2010; Tokarski, Tokarski, 2001; Śpiewak, 2014.

A proper liquidity level is essential for business continuity (and constant growth). Profits are the main source of asset and capital growth. High profitability and adequate liquidity are among the primary objectives of corporate finance management. Any associations between liquidity and profitability can only be analysed if a suitable approach is employed. The challenge is to try to reconcile two opposing objectives: to maximise value for owners and minimise the risk of liquidity crisis (Kuciński, 2018).

We investigated the associations between profitability and liquidity ratios using the Pearson correlation coefficient.

4. Results

Table 5 summarises the values of the results of the selected discriminant analysis models for the companies of interest from 2019 to 2021. Values below the model's threshold are displayed against a grey background.

Table 5.
Results of selected discriminant analysis models for the companies in 2019–2023

Items	H 2019	H 2020	H 2021	H 2022	H 2023
ACAUTOGAZ	2.326	2.332	2.393	2.687	2.341
AUTOPARTN	2.595	2.799	2.552	2.556	2.654
INTERCARS	1.713	2.180	2.053	2.032	1.982
SANOK	1.392	1.239	1.456	1.680	1.656
	Z6_2019	**Z6_2020**	**Z6_2021**	**Z6_2022**	**Z6_2023**
ACAUTOGAZ	1.382	6.122	5.168	8.195	5.269
AUTOPARTN	0.157	6.005	5.391	4.956	5.439
INTERCARS	-0.757	3.868	4.172	3.775	3.555
SANOK	-1.765	1.802	2.210	2.999	3.477
	Z7_2019	**Z7_2020**	**Z7_2021**	**Z7_2022**	**Z7_2023**
ACAUTOGAZ	7.691	6.017	5.075	7.706	5.051
AUTOPARTN	3.367	5.105	4.700	4.345	4.630
INTERCARS	2.377	3.178	3.472	3.123	2.885
SANOK	2.073	1.909	2.088	2.766	3.191
	POZ_2019	**POZ_2020**	**POZ_2021**	**POZ_2022**	**POZ_2023**
ACAUTOGAZ	3.426	3.153	2.664	3.933	2.952
AUTOPARTN	1.555	2.551	2.414	2.221	2.569
INTERCARS	1.436	2.019	2.143	1.908	1.921
SANOK	1.735	1.502	1.490	2.463	2.540
	W_2019	**W_2020**	**W_2021**	**W_2022**	**W_2023**
ACAUTOGAZ	1.056	0.704	0.556	0.631	0.283
AUTOPARTN	0.536	0.802	0.788	0.669	0.471
INTERCARS	-0.006	0.241	0.624	0.530	0.193
SANOK	-0.128	-0.093	-0.083	0.021	0.074

***** Column titles consist of abbreviated model name (H – Hadasik, Z6 – IE PAS Z6, Z7 – IE PAS Z7, POZ – Poznań, W –Wierzba) and the reference year.

Source: original work based on the financial statements of the companies

All companies exceeded the thresholds for three models (Hadasik, IE PAS Z7, and Poznań). These models established that the companies were in good financial standing.

Note two models that identified financial issues in two cases (Inter Cars SA and Sanok Rubber Company SA). IE PAS Z6's result for Inter Cars SA was –0.757 in 2019. Still, the next year saw a substantial improvement with 3.868. The company managed to preserve financial stability in consecutive years of the period, with results above the threshold from 2020 to 2023. These results clearly exceeded the threshold, and the company was in a safe zone despite the difficulties. Sanok Rubber Company SA went through some financial troubles in 2019, as evidenced by the result below the threshold (–1.765). Its situation improved in 2020 with 1.802 and high results in consecutive years. Later, both firms continued to reach model indicator values above the threshold, with much improved financial standings.

Inter Cars SA reached –0.006 in 2019, failing to achieve the threshold value, which indicates a risk of insolvency. It improved to 0.241 in 2020, reflecting a retreat from the risk zone. In 2021, it grew to 0.624. The result of 0.530 in 2022 indicates a secure position above the threshold; however, the decline to 0.193 in 2023 means the standing deteriorated and requires monitoring. Sanok Rubber Company SA was also below the threshold in 2019 (–0.128), risking insolvency (degrading financial standing). Poor results in 2020 and 2021

(–0.093 and –0.083, respectively) demonstrate a persistent risk of insolvency. In 2022, the situation improved to 0.021. Continued growth to 0.074 in 2023 confirms improving standing.

Both companies singled out by the models (Inter Cars SA and Sanok Rubber Company SA) were listed on the Warsaw Stock Exchange between 2019 and 2023 and were not excluded from the WIG Automotive index. The negative results of the discriminant analysis can be interpreted as indicating a deteriorating financial standing in the period of interest; however, the other models did not identify the companies' conditions as poor.

Table 6 summarises the association between values of the liquidity ratios and profitability ratios for the selected companies. The statistical technique is the Pearson correlation coefficient.

Table 6.
Pearson correlation coefficient

Company/indicator	ROE	ROA	ROS	CR	QR
ACAUTOGAZ					
ROA	0.990**				
ROS	0.807	0.811			
$C_{SH}R$	0.391	0.372	0.413		
QR	-0.544	-0.485	-0.678	-0.868	
CR	-0.196	-0.078	-0.400	-0.367	0.725
AUTOPARTN					
ROA	0.956**				
ROS	0.995***	0.962**			
$C_{SH}R$	-0.930*	-0.866	-0.922*		
QR	0.103	0.261	0.145	-0.339	
CR	-0.584	-0.369	-0.543	0.420	0.705
INTERCARS					
ROA	0.994***				
ROS	0.995***	0.999**			
$C_{SH}R$	-0.258	-0.169	-0.163		
QR	0.107	0.179	0.167	0.456	
CR	-0.302	-0.197	-0.207	0.917*	0.566
SANOK					
ROA	0.979**				
ROS	0.506	0.630			
$C_{SH}R$	0.901*	0.946*	0.824		
QR	0.846	0.832	0.591	0.881*	
CR	0.778	0.781	0.477	0.787	0.952*

Statistical significance levels: *: p-value < 0.05; **: p-value < 0.01; ***: p-value < 0.001.

Source: original work based on the financial statements of the companies.

AC SA (ACAUTOGAZ) exhibits a very strong positive correlation between return on assets and return on equity of 0.990. This correlation indicates effective use of assets, leading to a high return on equity. The correlation between quick ratio and return on equity is –0.544. Although not statistically significant, the association may suggest that AC SA achieves lower liquidity at a higher return on equity. It may be due to more asset investments or higher short-term liabilities, which may curb liquidity.

Auto Partner SA shows a very strong positive correlation between return on assets and return on equity of 0.956. This means that effective use of assets contributes to a better return on equity, reflecting proper asset management towards greater value for owners and investors. The correlation between return on sales and return on equity is 0.995, which is a high value. This shows that return on sales directly affects return on equity. The correlation between cash ratio and return on equity is –0.930, which is a strong negative relationship. An increased return on assets suggests lower liquidity, indicating that Auto Partner SA tends to invest in assets rather than hold cash.

The correlation between return on assets and return on equity for Inter Cars SA is 0.994, revealing a strong positive association. Hence, an increase in return on assets is conducive to better return on equity. This could suggest that the company effectively utilises its assets to boost profits at the equity level. The correlation between return on sales and return on equity is 0.995. This value also indicates a very strong positive link. This means that a higher return on sales is associated with a better return on equity, suggesting that the company achieves higher sales profits, leading to a more effective use of equity.

Sanok Rubber Company SA reached a correlation between return on assets and return on equity of 0.979, which is a strong positive value. This demonstrates that the company effectively manages its assets, driving a higher return on equity. The high correlation suggests that the company effectively puts its assets to work, generating profits at the level of equity. The correlation between cash ratio and return on equity is 0.901, which is a strong positive vector. High liquidity can enable the company to manage its capital more effectively and generate higher profits by utilising its resources.

The correlations between return on assets and return on equity are very strong for all companies, which may indicate that return on assets has a significant impact on return on equity. Therefore, companies that utilise their assets effectively tend to generate higher profits. In most examples, return on sales tends to be strongly positively correlated with return on equity, emphasising the role of operational efficiency in pursuing high return on equity. High return on sales may indicate a good organisation and competitive position. Liquidity metrics (cash ratio and quick ratio) exhibit inconsistent relationships with return on equity.

5. Discussion

The present results on the impact of the COVID-19 pandemic on the automotive industry display certain similarities and differences when compared to reports by other researchers. It is safe to say that the present study is more optimistic, as the general standings were good and there were no significant negative signs from the companies during the pandemic. According to the results from Hadasik's model, IE PAS's Z7 model, and the Poznań model,

not a single company reached a result below the threshold during the COVID-19 pandemic. The IE PAS's Z6 and Wierzba's models warned of poor standings for two companies.

Referring to the studies conducted by Pitera R., as cited in the literature review, it is evident that in 2015-2019 of the analyzed enterprises, including those operating in the automotive industry, exhibited poor financial condition. According to Pitera R., a potential threat to business continuity emerged in the years 2020-2021, which, in the author's view, confirms the observable impact of the COVID-19 pandemic, whose adverse effects materialized during that period. The findings obtained by the authors of the present study likewise indicate the emergence of early warning signals during the COVID-19 pandemic, as evidenced by the outcomes produced by certain predictive models.

Referring to the findings reported by Boratyńska K. and Yafremava K., as cited in the literature review, their results reveal notable discrepancies, as some of the applied models did not indicate bankruptcy risk among the analyzed entities, whereas other models employed in the study suggested that the enterprises were exposed to insolvency risk in 2018-2021. In light of these inconsistencies, the authors emphasized the necessity of applying multiple models in order to enhance the reliability of the diagnostic assessment. This conclusion is consistent with the findings obtained by the authors of the present study.

Boratyńska, Yafremava, and Pitera identified a deteriorated standing or threats to the financial standings of their analysed companies in 2020-2021.

The present study confirms hypothesis H1 that discriminant analysis models can effectively support the evaluation of financial standing and forecast insolvency risk in stable and unstable circumstances.

The conclusions from the present study align with the findings of other researchers regarding the general performance of discriminant analysis models in evaluating financial standing. Another common observation is that different models can yield divergent results. It is evident in the present study as IE PAS's Z6 and Wierzba's models warned of the risk of insolvency, while other models did not. This directly corroborates Boratyńska and Yafremava's conclusion that diagnostic reliability is improved by using multiple models. Therefore, the models are not only useful but also distinct in their characteristics.

The original study presented a unique analysis of the associations between profitability and liquidity in the automotive industry, highlighting their complexity and ambiguity. Therefore, the second hypothesis, H2, that there is an association between liquidity and profitability of the investigated companies over the period of interest cannot be fully confirmed.

6. Conclusions

The financial analyses and application of predictive models have yielded several relevant conclusions regarding the financial standing of the four WIG Automotive companies between 2019 and 2023.

The study analysed the financial standing of four automotive companies in Poland using five Polish discriminant analysis models. The results must not be generalised for the entire industry due to purposive sampling.

According to Hadasik's model, IE PAS's Z7 model, and the Poznań model, not a single company reached a result below the threshold during the COVID-19 pandemic. The IE PAS's Z7 and Wierzba's models warned of poor standings in the case of two companies (Inter Cars SA and Sanok Rubber Company SA). Inter Cars SA scored slightly lower during COVID-19, but remained in the secure zone, and its situation was stable over time. Despite better results in the last years of the period, Sanok Rubber Company SA remained below the threshold for Wierzba's model most of the time, which suggests that its position has to be monitored. Being more conservative, Wierzba's model can demonstrate stronger responses to poorer results. No increase in the number of negative discriminative model values occurred during the COVID-19 pandemic.

All the companies were in good or very good standing in the period of analysis. AC SA and Auto Partner SA fared the best. Inter Cars SA managed to maintain a steady financial standing despite lower results in recent years, which may be due to cost pressures or market limitations. Although Sanok Rubber Company SA has to be monitored, its better results for 2022-2023 promise a positive change and potential for future improvement. The analysis shows that discriminant analysis models can effectively support the evaluation of financial standing and forecast insolvency risk, especially during market disruptions, such as the COVID-19 pandemic. Together with traditional profitability measures, liquidity metrics, and correlation analysis, the models can offer a comprehensive assessment of a company's financial standing and identify potential risk areas.

The analysis of associations using the Pearson correlation coefficient has confirmed very strong positive correlations between return on assets and return on equity in all the investigated companies, suggesting that return on assets is a critical factor for achieving a high return on equity. The relationships between return on sales and return on equity were equally strong. This confirms the impact of operational effectiveness on the financial result. The relationships between liquidity and profitability were less clear. In some cases, there were significant negative correlations (such as those for Auto Partner SA and Inter Cars SA), suggesting a preference for investments over maintaining high liquidity. However, the correlations were positive for Sanok Rubber Company SA, indicating a more balanced financial strategy where

high fluidity does not disturb profitability. AC SA had a negative correlation between liquidity and profitability, which may suggest a more risky approach to working capital management.

Most of the discriminant analyses unambiguously assess their diagnostic reliability for the models. The study has confirmed the first research hypothesis (H1), which posits that discriminant analysis models accurately reflect a company's financial standing under both stable and unstable economic conditions in the country. This conclusion may be regarded as a practical implication of the present research. The findings concerning the association between liquidity and profitability for the companies tested with the Pearson correlation coefficient failed to identify a single relationship between the two groups of metrics. Therefore, the other hypothesis (H2) regarding an association between liquidity and profitability for the companies in the period of interest cannot be confirmed. The observed negative correlations between liquidity and profitability may also be examined within the framework of working capital management theory. The relationship between financial liquidity and profitability may depend on a firm's adopted strategy and its market position, which provides a potential interpretative context for the negative correlations identified in the study.

Another worthwhile aspect would be to discuss and apply international automotive insolvency prediction models to compare their outputs with those of the Polish models. A further challenge could be to build models insensitive to volatile economic environments and black swans (such as the COVID-19 pandemic).

The proposed research has application in the area of analysis and evaluation of companies from the WIG Automitive index during the pandemic crisis (2019-2023). The financial condition assessment of selected companies provides insight into the automotive industry's response from a capital market perspective. The presented results can be used by investors who wish to invest in the indicated sector index and are interested in assessing the resilience of these companies to crisis shocks. Furthermore, the presented research can be used for further comparative sectoral analyses and can support the formulation of economic policy.

The conducted research and its conclusions provide new knowledge about the functioning of companies on the Warsaw Stock Exchange, with particular emphasis on their financial condition during the economic crisis caused by the COVID-19 pandemic. An additional element of the research is the verification of the suitability of selected discriminant analysis models for assessing the financial situation of selected entities. The conducted research allowed for the assessment and identification of companies in terms of their resilience to the emerging crisis. The research contributes knowledge about the financial indicators used and the analysis of companies in the automotive sector during the pandemic.

Like all studies, this one also has certain limitations. Due to limited data availability, the study only considered the period during and after the COVID-19 pandemic, when the Polish economy was grappling with the impact of the pandemic crisis. This implies the need for future research, supplemented by additional years. Furthermore, the study was limited to selected companies that make up a specific index on the Warsaw Stock Exchange, meaning the research

should not be generalized. It should be noted that the presented research is based on the analysis of secondary data (primarily financial data with a lack of a qualitative perspective), and its quality may depend on the accounting standards of individual companies. In addition, such a restricted temporal scope reduces the statistical power of the correlation analysis between financial liquidity and profitability, as well as the stability of the Pearson correlation coefficients. As a result, it is not possible to unequivocally confirm the second research hypothesis (H2) concerning the existence of a relationship between liquidity and profitability among the analyzed entities.

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