*Bankruptcy prediction for the manufacturing
sector in V4 countries
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BANKRUPTCY PREDICTION FOR THE MANUFACTURING SECTOR IN V4 COUNTRIES

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Abstract:

Research background: Nomenclature of Economic Activities NACE C includes the wide spread of enterprises, such as manufacturers of machinery and equipment, motor vehicles, trailers, semi-trailers, other transport equipment, etc., which affect many other sectors and imply importance for each economy and common region of countries. Because of this fact, it is important to analyse and predict the direction of corporate finance, focusing on financial health and bankruptcy.

Purpose of the article: The aim of this article is to map the level of bankruptcies in the manufacturing sector at Visegrad Group using a specific prediction model. The forecasting of the prosperity of enterprises covers the period before and during the COVID-19 pandemic period to identify the consequences of the pandemic. Developments in ratios for profitability, indebtedness, and liquidity, along with indicators of the composition of assets and liabilities, also support this investigation.

Methods: The study was realised based on a sample of 12,336 entities for the period 2017–2021. The median values of the selected variables were illustrated individually per country. Then predictions for the sample of Czech, Hungarian, Polish, and Slovak enterprises were run via a model created for conditions in transitive economies. The numbers of bankruptcies were described individually and for the whole region as well.

Findings & Value added: The predictions showed that the lowest number of non-prosperous entities was in 2017 and the biggest one in 2020. Thus, it was evidenced that the COVID-19 pandemic had an impact on the financial health of the manufacturing sector in the analysed region. Academicians may use this methodology and replicate it for other sectors, including services within transition markets. Practical implications serve to remove animosity among enterprises against prediction models because they have proven to be an early and effective tool of prevention during normal and crisis periods.

Keywords: bankruptcy; corporate finance; manufacturing; prediction; Visegrad Group

JEL Classification: G17; G33; L60

1. Introduction

Managerial decision-making is a significant determinant that impacts business performance. Business performance is one of the defining attributes of competitiveness in the market (Farida and Setiawan, 2022). Economic and financial analysis is an integral component of financial management to make successful decisions and provide a prosperous future without failure (Stefko et al., 2019). But corporate failure may take place in diverse forms and scales, with varying consequences for a contingent of stakeholders depending on the severity and nature of the failure. The growing number of various forms of corporate failure has resulted in the adoption of diverse definitions and connotations associated with failure (Kliestik et al., 2019). Then, a clear understanding and correct prediction of the financial health of a business are critical factors for its success and survival in the market. It is essential that the business maintain a healthy financial situation by setting financial goals and controlling them (Potkany et al., 2023). Kontus and Mihanovic (2019) note that the goal is to display summary data about the financial situation of the company, not only from the present but also regarding prospects. Osiichuk and Mielcarz (2020) describe the goals more comprehensively. They highlight that it is necessary to display summary data about the financial situation of the company to identify weaknesses and possible risks that could result in financial problems and to determine strengths and possible opportunities that could be improved in the future.

The financial management of businesses should be prepared for both anticipated situations and unanticipated crises, such as the COVID-19 pandemic (Kurniawan et al., 2023), that can have an impact on financial decisions. The World Health Organization officially recognized the COVID-19 illness as a pandemic on March 11, 2020. It was classified among the deadliest contagious illnesses (Ben-Ahmed et al., 2022). The crisis that the COVID-19 outbreak caused has had a significant impact on the global economy. The recession was presumed to be the most severe downturn since the era of World War II (Gebski, 2021). The economic ramifications of the epidemic have been amplified as global interconnectedness grows (Kolahchi et al., 2021). The market environment was susceptible to daily fluctuations during the COVID-19 pandemic. In addition, there were several adverse phenomena, including volatility in financial instrument prices, information asymmetry, financial instability, the rapid increase in unemployment, corporate insolvencies, and bankruptcies. This era has compelled numerous industries and businesses to implement "strategic turn" actions, which are distinguished by a broad and even comprehensive scope of required changes, a significant amplitude, a rapid distribution of changes over time (including the so-called crisis waves and other specific unpredictability of the crisis), and a rapid pace of actions and changes implemented (Obrenovic et al., 2020). Therefore, the companies had to monitor their financial health in more detail and be prepared to deal with such unforeseen circumstances (Exenberger and Kavcakova, 2020; Gavurova et al., 2022).

The COVID-19 pandemic has affected various sectors. Tourism, travel, hospitality, supply chains, consumption, production, operations, valuations, security, financial strain, and the costs of all goods—including fossil fuels and renewable energy sources—have been profoundly impacted by the massive uncertainty caused by COVID-19 (Chang et al. 2020). The number of unproductive companies has been increasing during the pandemic (Boratynska, 2021). The increase in bankruptcies has been disclosed also in manufacturing, which is a fundamental pillar of global economies (Berent and Rejman, 2021; Horvathova and Mokrisova, 2020). Meyer and Hassan (2020) discuss that the dynamic and growing manufacturing sector is critical for growth and that this sector is globally known as the "engine of growth" regardless of the phase of the economic cycles. Suhanyi et al. (2023)

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prove its importance within the EU, including Visegrad Group countries (Czech Republic, Hungary, Poland, and Slovakia).

Thus, the aim of this study is to map the level of bankruptcies in the manufacturing sector at Visegrad Group using a specific prediction model. Blazek et al. (2023) confirm the significance of evaluating business performance by financial indicators in the region of Visegrad Four (V4). However, the novelty of this research consists of focusing on the failures of enterprises in the chosen sector (NACE C), covering the pre-crisis and crisis periods. In addition, an explanation of the development of eleven financial ratio indicators from 2017 to 2021 is provided. The applied bankruptcy prediction model is constructed based on these ratios.

The article is structured as follows: Firstly, the research background, significance, and novelty are discussed. The creation of samples from the manufacturing sector and the methodology used to replicate the study in other transition economies are covered in Chapter 2. The research results include the number of prosperous and non-prosperous enterprises during the period mentioned in Chapter 3. The findings from V4 are compared with the conclusions of the last studies from similar markets in Chapter 4. Finally, the limitations of this study are defined, and future research directions are highlighted.

2. Methodology

This research focuses on the manufacturing sector during the period 2017-2021. This period was chosen to cover the pre-crisis as well as the era of the pandemic. Ding et al. (2023) stress the importance of predicting corporate financial distress in the pre-COVID period. Bozkurt and Kaya (2023) add mapping bankruptcies and financial distress in the COVID-19 crisis as well. Valaskova et al. (2023) highlight the necessity of identifying bankruptcies based on the financial information for all sectors that operated in the Visegrad Group countries. That is why the following methodological steps were used:

1. Creation of the sample

The basis of the financial study was the ORBIS database, which contains data on 400 million global commercial and public enterprises and is used to predict bankruptcy in transition economies (Gajdosikova et al., 2022). The provider of the mentioned database is Bureau van Dijk. The study maps the V4. The final sample consists of 12,336 companies from NACE C after removing missing cases. Table 1 shows the number of enterprises for each country. The equal subsamples were used for each from the analysed period.

Table 1: The structure of the final sample of enterprises in V4 countries

V4 countries	Number of entities
Czech Republic (CZ)	2036
Hungary (HU)	1696
Poland (PL)	4566
Slovakia (SK)	4038
Sum	12,336

Source: own research

2. Running bankruptcy model

Lesakova et al. (2020) note that the bankruptcy risk of a company must be predicted using financial models. However, the lack of usage of these models is mostly due to their ignorance. It is recommended to apply prediction models to research and management work. The most prominent instruments used to assess the financial condition of an organisation consist of bankruptcy models (Vavrek et al., 2021). Present bankruptcy prediction models serve as a viable instrument for forecasting the financial problems that may affect enterprises (Stefko et

al., 2020). The domain of international financial forecasting comprises fundamental models, such as Altman's Z-score or Springate, Ohlson, and Zmijewski models, which are widely recognised and serve as foundational elements for numerous modified models (Karpac and Bartosova, 2020). Kliestik et al. (2019) created a prediction bankruptcy model for the conditions of transitive economies (TE) using the discriminative function y (Z-score), and it was used for prediction in the delivered study (equation 1).

$$
\begin{aligned}
y_{TE} = {} & -1.880 + 0.017X_2 - 0.024X_4 + 2.291X_{10} - 0.348X_{11} + 0.552X_{12} \\
& + 1.121X_{15} - 0.013X_{22} + 0.007X_{26} + 0.546X_{27} - 0.435X_{28} \\
& - 0.903X_{35} + 0.639\text{small} + 0.197\text{medium} - 0.113\text{BG} - 0.238\text{HR} \\
& - 0.112\text{CZ} - 0.48\text{EE} - 0.238\text{HU} + 1.037\text{LV} + 0.249\text{RO} - 0.409\text{RS} \\
& - 0.334\text{SI} + 0.387\text{NACE}_B + 0.097\text{NACE}_C + 0.33\text{NACE}_D \\
& + 0.169\text{NACE}_F + 0.578\text{NACE}_I + 0.23\text{NACE}_J + 0.348\text{NACE}_N \\
& + 0.36\text{NACE}_P
\end{aligned}
\tag{1}
$$

where

$$X_2 = \frac{\text{Current assets}}{\text{Current liabilities}}$$

$$X_4 = \frac{\text{Net profit}}{\text{Equity}}$$

$$X_{10} = \frac{(\text{Noncurrent liabilities} + \text{Current liabilities})}{\text{Total assets}}$$

$$X_{11} = \frac{\text{Current assets}}{\text{Total assets}}$$

$$X_{12} = \frac{\text{Cash and cash equivalents}}{\text{Total assets}}$$

$$X_{15} = \frac{\text{Current assets}}{\text{Total liabilities}}$$

$$X_{22} = \frac{\text{Cash and cash equivalents}}{\text{Current liabilities}}$$

$$X_{26} = \frac{\text{Current assets} - \text{inventory}}{\text{Current liabilities}}$$

$$X_{27} = \frac{\text{Earnings after tax (EAT)}}{\text{Total assets}} \cdot 100$$

$$X_{28} = \frac{\text{Earnings after tax (EAT)}}{\text{Equity}} \cdot 100$$

$$X_{35} = \frac{\text{Earnings before tax (EBT)}}{\text{Operating profit}}$$

Using equation 1, it is possible to predict the future development of companies in transitive economies or classify them in the group of prosperous or non-prosperous enterprises. Since a constant is also used in the model, the resulting discrimination score is compared with the weighted average of the group centroids, which in this case is 0. It is then decided according to the rule that if the resulting Z-score is negative, the company is prosperous; in the case of a

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positive Z-score value, the enterprise is included in the group of non-prosperous enterprises. If the business entity belongs to the category of small or medium-sized enterprise, it is located in the countries of Croatia (HR), Estonia (EE), Romania (RO), Bulgaria (BG), Slovenia (SI), Latvia (LV), Serbia (RS), and the Czech Republic (CZ), or it belongs to one of the NACE categories: B (mining and quarrying), C (manufacturing), D (electricity, gas, steam, and air conditioning supply), F (construction), I (accommodation and food service activities), J (information and communication), N (administrative and support service activities), or P (education), the value of the variable is equal to 1, otherwise 0.

The modification, followed by verification of predictive capability within a particular kind of economy and sector, is the advantage of prediction models. But Kitowski et al. (2022) also detect the disadvantage that it is advisable to employ discriminant and logit models to evaluate the likelihood of bankruptcy, together with other existing techniques for analysing the financial state of the company, such as risk scoring approaches and classic ratio analysis. Kovacova et al. (2019) and Kliestik et al. (2020) support the analysis of financial variables and indicators applied in bankruptcy models. The eleven ratios (X_2, X_4, X_{10}, X_{11}, X_{12}, X_{15}, X_{22}, X_{26}, X_{27}, X_{28}, X_{35}) from the prediction model mentioned were analysed individually for each country to depict their development over time. It was used IBM SPSS Statistics for calculation.

3. Results

Firstly, the descriptive statistics of the individual indicators was described. Then, it was graphically illustrated the development during the monitored period, that is, for the years 2017, 2018, 2019, 2020 and 2021. Finally, based on prediction models, the businesses from manufacturing sector were divided into prosperous and non-prosperous ones.

Table 2 shows the individual values of the medians of all ratios for each V4 country over a period of five years.

*Table 2: Median values of the variables of V4 country*

Country	Year	X_2	X_4	X_{10}	X_{11}	X_{12}	X_{15}	X_{22}	X_{26}	X_{27}	X_{28}	X_{35}
SK	2017	1.21	0.10	0.61	0.58	0.12	0.95	0.27	0.84	3.01	10.38	0.02
	2018	1.22	0.09	0.60	0.58	0.13	0.96	0.30	0.82	2.70	9.27	0.02
	2019	1.25	0.08	0.57	0.56	0.13	0.98	0.32	0.85	2.36	7.88	0.02
	2020	1.35	0.07	0.55	0.57	0.15	1.01	0.39	0.92	2.09	6.87	0.02
	2021	1.37	0.08	0.55	0.60	0.14	1.06	0.37	0.91	2.58	8.37	0.02
CZ	2017	1.94	0.10	0.43	0.63	0.18	1.38	0.54	1.24	5.63	10.23	0.04
	2018	1.98	0.09	0.43	0.63	0.16	1.37	0.53	1.23	5.14	9.26	0.03
	2019	2.03	0.09	0.42	0.63	0.17	1.40	0.60	1.28	4.67	9.04	0.03
	2020	2.15	0.08	0.40	0.62	0.20	1.49	0.76	1.38	4.23	7.85	0.03
	2021	2.06	0.09	0.42	0.66	0.19	1.50	0.64	1.25	4.85	8.88	0.04
PL	2017	1.57	0.11	0.47	0.58	0.07	1.18	0.21	1.01	5.10	11.28	0.03
	2018	1.58	0.12	0.47	0.57	0.07	1.17	0.21	0.99	5.09	11.55	0.03
	2019	1.60	0.11	0.46	0.57	0.08	1.19	0.24	1.01	5.14	10.98	0.04
	2020	1.75	0.12	0.45	0.58	0.12	1.26	0.39	1.13	5.75	11.57	0.04
	2021	1.71	0.14	0.45	0.60	0.10	1.29	0.29	1.04	7.31	14.48	0.05
HU	2017	1.60	0.10	0.46	0.58	0.19	1.22	0.53	1.02	5.16	10.30	0.04
	2018	1.56	0.11	0.47	0.58	0.18	1.22	0.48	0.95	5.27	10.66	0.04
	2019	1.52	0.09	0.46	0.56	0.18	1.21	0.51	0.93	4.63	9.43	0.03
	2020	1.60	0.10	0.48	0.57	0.22	1.19	0.67	1.04	4.79	9.84	0.04
	2021	1.57	0.12	0.79	0.59	0.21	1.19	0.57	0.97	5.62	11.54	0.05

Source: own research

Figure 1 shows the median values of the X_2 (current ratio) for individual V4 countries during the analysed period. The median of the ratio of current assets to current liabilities of

the monitored industry for the country of Slovakia had an increasing trend during the analysed years. For the Czech Republic, the trend was increasing only until 2020, and in 2021 there was a decrease. For Poland, the development of the median value followed the same course as for the Czech Republic. The last V4 country is Hungary, where the development of the median had a downward trend until 2019. In 2020, the median was at the same level as in 2017, but in the last analysed year, a further decrease occurred. The smallest median value was recorded in 2017, at 1.21 in the Slovak Republic.

Figure 1: Development of the median X_2 value in V4 countries
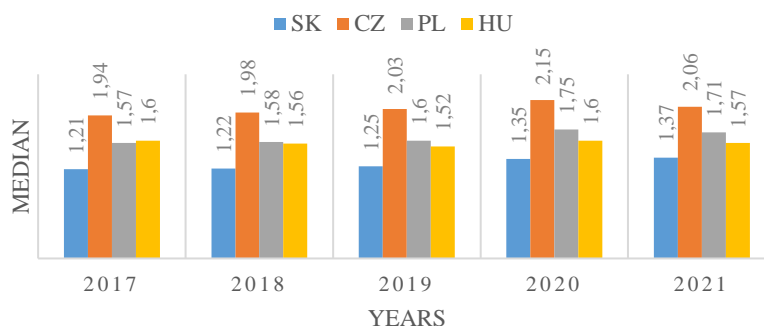
Source: own research

Figure 2 shows the median values of the X_4 (return on equity based on net profit) for individual V4 countries during the analysed period. The median of the ratio of net profit to equity of the monitored industry for the country of Slovakia had a decreasing trend until 2020; the increase occurred only in 2021. For the Czech Republic, the trend was decreasing. For Poland, until 2020, the development of the median value had an alternating course, and the increase occurred only in 2021. The last V4 country is Hungary, where the development of the median had the same course of trend until 2020, and an increase was recorded in 2021. The largest median value was recorded in 2021, at 0.14 in Poland.

Figure 2: Development of the median X_4 value in V4 countries
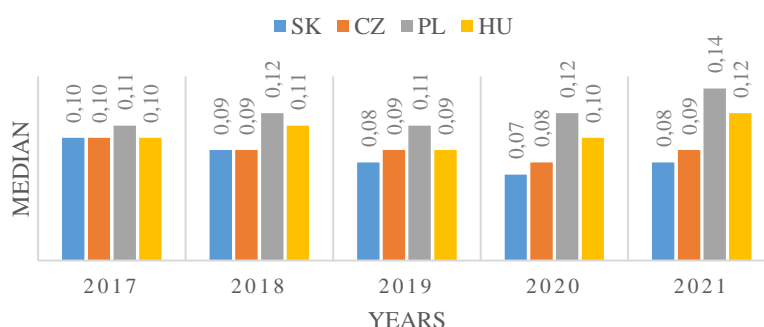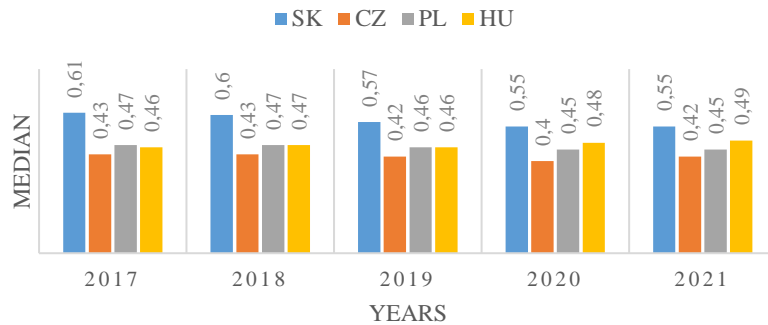

Source: own research

Figure 3 shows the median values of the X_{10} for individual V4 countries during the analysed period. The median of the ratio of noncurrent and current liabilities to total assets of the monitored industry for the country of Slovakia had a downward trend until 2020, and there was no change in 2021. For the Czech Republic, the median value of the ratio was unchanged in the first two years, and from 2018 to 2020, the trend was decreasing. In 2021, the median value rose again. For Poland, until 2020, the development of the median value had the same course as in the Czech Republic, and in 2021, the value of the indicator did not

change. The last V4 country is Hungary, where the development of the median had an alternating trend until 2020, and an increase was recorded in 2021. The lowest median value was recorded in 2020, at 0.40 in the Czech Republic.
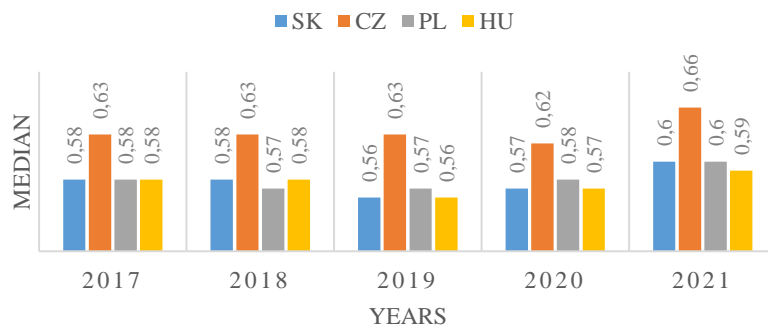
Figure 3: Development of the median X_{10} value in V4 countries

Figure 4 shows the median values of the X_{11} for individual V4 countries during the analysed period. The median of the ratio of current assets to total assets of the monitored industry for the country of Slovakia had a decreasing trend until 2019, and from 2020 on, the development had an increasing trend. For the Czech Republic, the median value of the ratio was unchanged in the first three years; in 2020, there was a decrease; and in 2021, the median value increased. For Poland, until 2019, the development of the median value had a decreasing course, and from 2020 on, the value of the indicator increased. The last V4 country is Hungary, where until 2018 the development of the median was the same; a decrease was recorded in 2019, and since 2020 the development of the indicator value has been increasing. The highest median value was recorded in 2019, at 0.56 in the Slovak Republic.

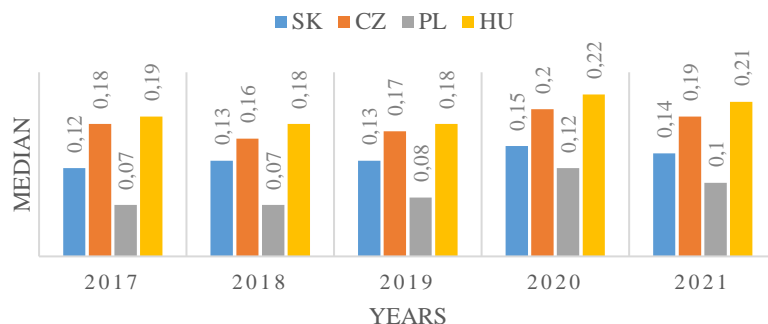*Figure 4: Development of the median X_{11} value in V4 countries*

Figure 5 shows the median values of the X_{12} for individual V4 countries during the analysed period. The median of the ratio of cash and cash equivalents to total assets of the monitored industry for the country of Slovakia had an increasing trend until 2020, and in 2021 there was a decrease. For the Czech Republic, in the first three years, the median value of the ratio was alternating; in 2020, there was an increase; and in 2021, the median value decreased. For Poland, until 2020, the development of the median value had an increasing course, and in 2021, the value of the indicator decreased. The last V4 country is Hungary, where until 2019 the development of the median had a downward trend, an increase was recorded in 2020, and

a decrease in the value of the indicator in 2021. The highest median value was recorded in 2020, at 0.22 in Hungary.
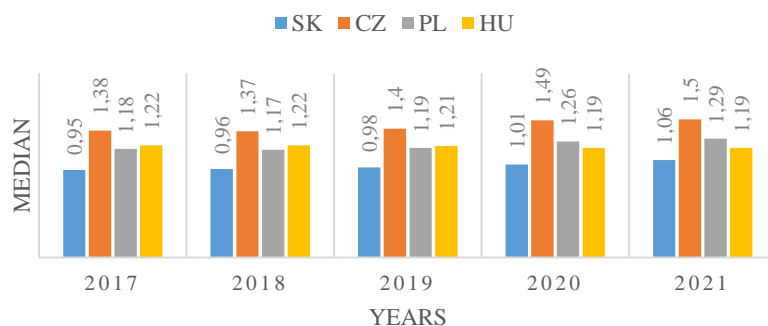
Figure 5: Development of the median X_{12} value in V4 countries

Source: own research

Figure 6 shows the median values of the X_{15} for individual V4 countries during the analysed period. The median ratio of current assets to total liabilities of the monitored industry in Slovakia had a growing trend throughout all the years. For the Czech Republic, in the first two years, the median value of the ratio is decreasing, and from 2019 on, the median value is increasing. For Poland, the development of the median value followed the same course as in the case of the Czech Republic. The last V4 country is Hungary, where the median value had a downward trend. The lowest median value was recorded in 2017, at 0.95 in the Slovak Republic.
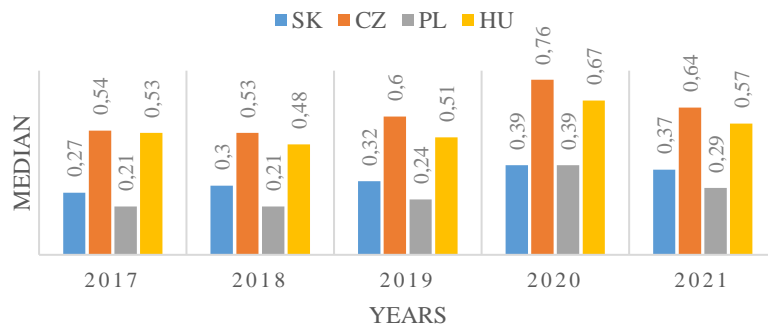
Figure 6: Development of the median X_{15} value in V4 countries

Source: own research

Figure 7 shows the median values of the X_{22} (cash ratio) for individual V4 countries during the analysed period. The median of the ratio of cash and cash equivalents to current liabilities of the monitored industry for the country of Slovakia had an increasing trend during the first four years, and in 2021 there was a decrease in the median value. For the Czech Republic, a slight decrease in the development of the median value of the ratio can be seen in the first two years; from 2018 to 2020, the median value increased. In 2021, there was a decrease, as in the previous case. For Poland, until 2020, the development of the median value had an increasing course, and in the last year, its value decreased. The last V4 country is Hungary, where the median value had the same course as in the case of the Czech Republic. The highest median value was recorded in 2020, at 0.76 in the Czech Republic.

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Figure 7: Development of the median X_{22} value in V4 countries

Source: own research

Figure 8 shows the median values of the X_{26} (quick ratio) for individual V4 countries during the analysed period. The median of the ratio of the value of current assets without inventory to current liabilities of the monitored industry for the country of Slovakia had during the first three years an alternating trend; in 2020, the median value increased, but in 2021, it decreased again. For the Czech Republic and Poland, the development of the median value of the ratio had the same trend as in the case of the Slovak Republic. The last V4 country is Hungary, where the median value had a decreasing trend until 2019; in 2020, the median value increased; and in 2021, it decreased again. The lowest median value was recorded in 2018, at 0.82 in the Slovak Republic.
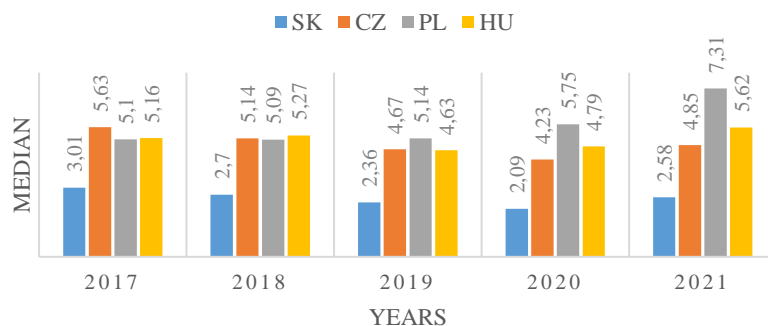
Figure 8: Development of the median X_{26} value in V4 countries
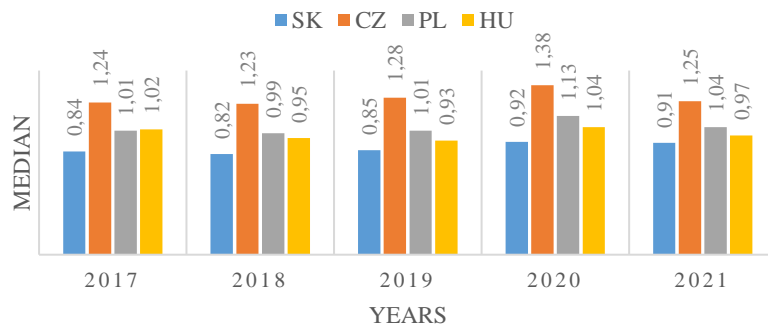
Source: own research

Figure 9 shows the median values of the X_{27} (return on total assets based on EAT) for individual V4 countries during the analysed period. The median of the ratio of EAT to total assets of the monitored industry for the countries of Slovakia and Czech Republic had, during the first four years, a decreasing trend; in 2021, its value increased. For Poland, the development of the median value had in the first two years a downward trend, and from 2019 on, the direction of the trend changed. The last V4 country is Hungary, where the median value had until 2018 an increasing trend. In 2019, the value of the median decreased, and since 2020 it has increased again. The highest median value was recorded in 2021, at 7.31 in Poland.
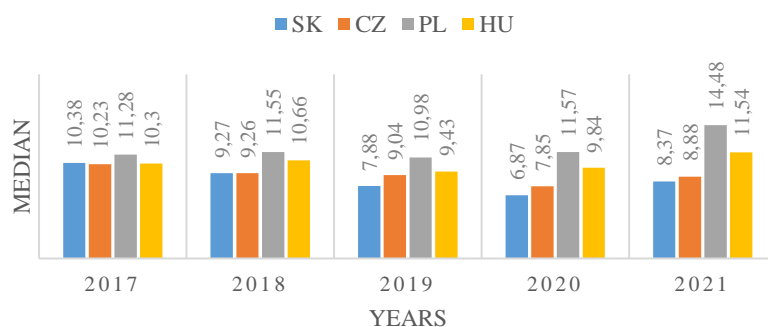
Figure 9: Development of the median X_{27} value in V4 countries

Source: own research

Figure 10 shows the median values of the X_{28} (return on equity based on EAT) for individual V4 countries during the analysed period. The median of the ratio of EAT to equity of the monitored industry for the countries of Slovakia and the Czech Republic had the same trend during the analysed period. For Poland and Hungary, the development of the median value was the same. The lowest median value was recorded in 2020, at 6.87 in Slovakia.

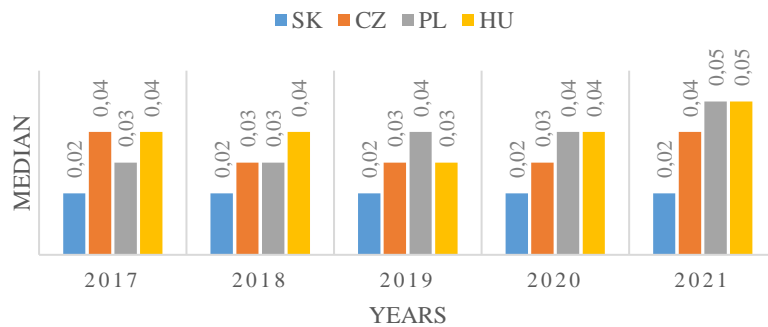*Figure 10: Development of the median X_{28} value in V4 countries*

Source: own research

Figure 11 shows the median values of the X_{35} for individual V4 countries during the analysed period. The median of the ratio of EBT to operating profit of the monitored industry for the country of Slovakia had an unchanging trend. For the Czech Republic, the median value of the ratio decreased in 2018; until 2020, the trend was unchanged; and in 2021, the value rose to the same level as in 2017. For Poland, the development of the median value had an increasing trend during the analysed period. The last V4 country is Hungary, where the development of the median decreased in 2019, and since 2020, the trend has started increasing. The highest median value was recorded in 2021, at 0.05 in Poland and Hungary.

Next, it was compared among individual V4 countries according to their total number of prosperous and non-prosperous enterprises over a five-year period.

Table 3 shows the number of enterprises in Slovakia, which we divided into prosperous and non-prosperous enterprises using equation (1). The highest number of thriving businesses was in 2017, 2147 businesses, while the lowest number was in 2020, 1783 businesses, which was caused by the COVID-19 crisis. In the same way, non-prosperous enterprises reached the highest number in 2020, 2255 enterprises, which was also caused by COVID-19, on the contrary, the lowest was in 2017, 1889 enterprises.

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Figure 11: Development of the median X_{35} value in V4 countries

Source: own research

Table 3: Bankruptcy prediction in Slovakia

Slovakia	2017	2018	2019	2020	2021
Prosperous	2149	2033	1906	1783	1895
Non-prosperous	1889	2005	2132	2255	2143

Source: own research

The bankruptcy prediction in Slovakia was also graphically illustrated in Figure 12, where it can be demonstrated how the development in the number of prosperous and non-prosperous enterprises changed during the analysed period. It is depicted that in 2019, which is characteristic of the beginning of the pandemic, there was a change, and from 2019 to 2020, the number of non-prosperous business entities increased. The situation started to improve only in 2021.

Figure 12: Development in the sample of Slovakia
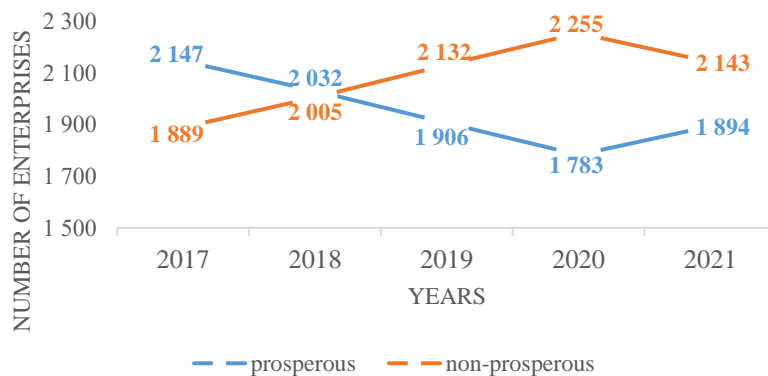
Source: own research

Table 4 shows the number of enterprises divided into prosperous and non-prosperous enterprises for the country of the Czech Republic.

Table 4: Bankruptcy prediction in Czech Republic

Czech Republic	2017	2018	2019	2020	2021
Prosperous	888	863	828	773	833
Non-prosperous	1148	1173	1208	1263	1203

Source: own research

In Figure 13, there is a graphic representation of the enterprises of the Czech Republic. It was observed that the greater parts of the enterprises are represented by non-prosperous enterprises. Like Slovakia, the Czech Republic achieved the highest number of enterprises in

2017, with 888 enterprises. On the other hand, the lowest number of prosperous businesses was achieved in 2020, which was 773 businesses, which could be due to the COVID-19 pandemic. On the other hand, the number of non-prosperous businesses was the highest in 2020, at 1263, which was again due to the ongoing COVID-19 pandemic. The lowest number of non-prosperous businesses was in 2017, with 1148 businesses.

Figure 13: Development in the sample of Czech Republic
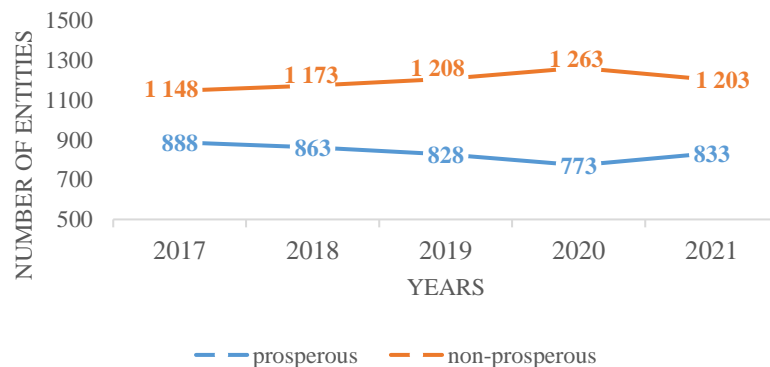
Source: own research

During the analysed period, Poland had an almost equally divided number of enterprises into prosperous and non-prosperous ones. Table 5 shows that there were again the most non-prosperous businesses in the pandemic year of 2020: 2355 businesses. In the following year, their number decreased by 197 enterprises, and at the same time, it represents the lowest number of non-prosperous enterprises in the monitored period. Prosperous businesses had the opposite development as non-prosperous ones. Their number has been decreasing over the years, and the lowest number was reached in 2020, at 2210 businesses, due to the pandemic. However, the year 2021 represents an increase of 197 enterprises to 2407 enterprises.

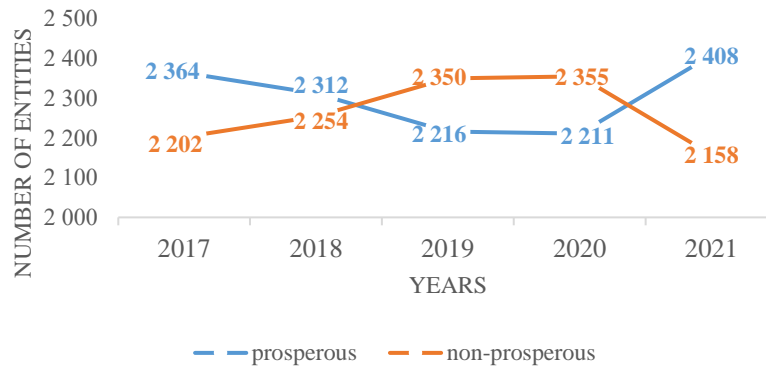*Table 5: Bankruptcy prediction in Poland*

Poland	2017	2018	2019	2020	2021
Prosperous	2364	2312	2216	2211	2408
Non-prosperous	2202	2254	2350	2355	2158

Source: own research

Figure 14 graphically shows the development of the number of enterprises in Poland over the monitored 5 years. It can be described how the number of prosperous ones gradually decreased, especially in the pandemic years. On the other hand, the number of non-prosperous ones has increased. After 2020, when businesses started to recover from the COVID crisis, their number changed again in 2021, meaning that there were more prosperous than non-prosperous businesses.

From Table 6, it was derived that the number of prosperous and non-prosperous enterprises was relatively the same in Hungary. However, the exception is the year 2019, when 111 prosperous businesses became non-prosperous due to COVID-19. Their number changed again the following year. The number of prosperous enterprises decreased to 779 enterprises; this number also represents the lowest number in the monitored five years. This means that the number of non-prosperous companies increased by 13. This year saw the highest number of non-prosperous enterprises, 917 enterprises.

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Figure 14: Development in the sample of Poland

Source: own research

Table 6: Bankruptcy prediction in Hungary

Hungary	2017	2018	2019	2020	2021
Prosperous	834	820	792	779	851
Non-prosperous	862	876	904	917	845

Source: own research

Thus, it was proven that the pandemic of the viral disease COVID-19 had a meaningful impact in the V4 region in the critical year 2020. There is an assumption of a gradual return to the original state from the pre-COVID-19 era based on decreased values of 6349 predicted bankruptcies in 2021 (Table 7).

Table 7: Bankruptcy prediction in Visegrad Group

V4	2017	2018	2019	2020	2021
Prosperous	6235	6028	5742	5546	5987
Non-prosperous	6101	6308	6594	6790	6349

Source: own research

Based on Figure 15, it was noted that the number of non-prosperous enterprises was more prevalent than the prosperous ones. It is also possible to observe the overall development of the number of enterprises during the monitored period. However, in the last year, 2021, there was a change when the number of prosperous enterprises exceeded the number of non-prosperous ones by six enterprises.

Figure 15: Development in the sample of Hungary
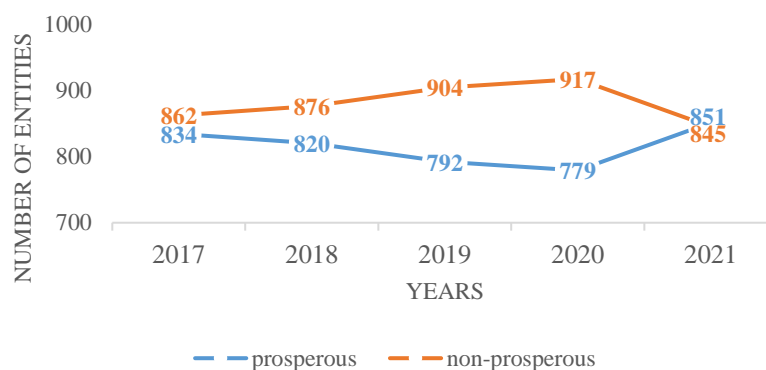
Source: own research

4. Discussion

The recent results from investigations within Central and Eastern Europe (CEE) related to the bankruptcy were discussed. Marczewska et al. (2023) encourage the comparison of Central CEE countries and explain that initially, these nations were comparable in that they all experienced the transition from a centrally planned to a market economy. Secondly, because they are all EU members, their regulatory frameworks and values are comparable. Thus, in terms of the framing conditions, it is a rather homogeneous group.

Papik and Papikova (2023) analyse the influence of the crisis on the efficacy of bankruptcy prediction models. Information spanning from 2015 to 2019 was gathered for over 90,000 small and medium-sized enterprises (SMEs) to construct predictive models for three distinct time periods: two normal periods and one period marked by a crisis. Predictions were produced for one-year, two-year, and three-year periods using the CatBoost, LightGBM, and XGBoost techniques. The findings of this publication suggest that the predictive models exhibited considerably worse performance during crisis situations compared to non-crisis periods. The most noticeable decline was observed in the accuracy of one-year projections, which decreased by 6.5%. The disparity was marginally reduced for forecasts spanning two years (4.8%) and three years (4.1%). Given that lower sensitivity levels resulted in poorer performance during crisis periods, it may be inferred that these bankruptcies were unforeseen and likely triggered by the crisis. They conclude that after the COVID-19 situation, it will be necessary to revalidate and recalibrate the current bankruptcy models.

Using twelve key debt ratios, Gajdosikova et al. (2023) evaluate the degree of indebtedness of 3509 businesses. The nonparametric Kruskal-Wallis test was then used to conduct a more thorough analysis that addressed statistically significant differences between distinct indebtedness ratios in connection to size and legal form. To identify the location of stochastic ascendancy, they made use of the Bonferroni correction. Due to the size of the enterprises and their legal structure, the Kruskal-Wallis test result showed statistically significant differences in the debt ratio values.

Krasteva and Nagy (2022) examine the financial stability of NACE H (transportation and storage) and prove the importance of financial health prediction. Four models (Altman's model, Taffler's model, the discrimination model for Slovakia, and the discrimination model for Slovakia in NACE H) were used for the bankruptcy prediction of 601 businesses. Selected models were evaluated using ROC (receiver operating characteristic) curves. They identified and detailed in greater depth which models should continue to be employed in the investigated sector based on the results that were obtained.

These aviation-related discoveries came from the investigation by Faizuloyeva and Olechowska (2021). Greater stability in an organisation leads to a reduced risk of bankruptcy, even in the face of unforeseen market changes. Based on the five-factor model of Altman, their financial analysis indicates that, as of December 31, 2020, the analysed firm is financially unstable and experiencing a declining trend in the Z-score. The outcome may be attributed to a significant decrease in demand, which is the impact of the COVID-19 pandemic. During the entirety of 2020, the analysed entity facilitated the transportation of 30.2 million passengers, representing a decrease of 50.3% compared to the same period in 2019. The passenger seat occupancy rate in the group declined by 8.3 percentage points compared to the same time the previous year, reaching 73.6%. The business entity had a 56.5% decline in passenger turnover compared to the corresponding time in the previous year. The calculations of the Altman model indicated that the analysed entity is in an unstable situation, as seen in the market. The link between computation and observational reality

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serves as evidence of the enduring relevance of the Altman model in evaluating financial conditions and forecasting future patterns.

Wieczorek-Kosmala (2021) realises an examination utilising sample data from the hospitality sector of V4 countries. The findings revealed that the level of financial risk preparedness is relatively low. An empirical investigation has verified that around 25% of the examined hospitality firms had a poor or extremely low degree of risk preparation. 25% of enterprises are unable to manage the initial financial challenges that arose quickly after the COVID-19 outbreak, making them very susceptible to bankruptcy. Approximately 34% of the firms analysed demonstrated a moderate level of readiness for potential risks. Overall, almost 60% of the surveyed enterprises are susceptible to the repercussions of operational interruptions.

5. Conclusions

Predicting the financial health of a company is crucial for all businesses in the current globalised world, but particularly for manufacturing ones that affect each economy in a significant manner. The concept of predicting business failure is well-established on an international level, and numerous prediction models have been developed to assess financial well-being and, consequently, ascertain its propensity for either financial prosperity or insolvency of the company. However, there is a preference to use models designed to forecast business failure that are developed exclusively for a single country or even a subsector of the domestic economy.

The main aim of this study is to map the level of bankruptcies in the manufacturing sector at Visegrad Group using a specific prediction model. The descriptive statistics variables for the chosen ratios were calculated based on the discriminant function of prediction models and graphically illustrated their development during the observed period using the median value. Then, using the Z-score for transition economies, the number of successful and unsuccessful enterprises was identified for the sample of 2036 Czech enterprises, 1696 Hungarian enterprises, 4566 Polish enterprises, and 4038 Slovak enterprises. The research evaluated the period before and during the COVID-19 pandemic. The fewest bankruptcies were revealed in 2017, with 6101 enterprises. The most bankruptcies were revealed in 2020: 6790 enterprises. Thus, it was established that in the crucial year 2020, the COVID-19 pandemic had a significant effect on the V4 area. Based on declining values of 6349 projected bankruptcies in 2021, a gradual restoration to the pre-COVID-19 original status is assumed.

The limitations of this study are that it focuses only on one sector and only on V4 countries. This research could be extended with an analysis of the period after the COVID-19 pandemic. Future research can also be extended to related sectors of NACE C and focus on other European countries in the group of transition economies.

Conflicts of Interest: The authors declare no conflict of interest.

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