

WERE THE MANUFACTURING COMPANIES RESILIENT IN THE FACE OF COVID-19 OR DID THEY TAKE ADVANTAGE?

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Article History:

- received 12 May 2023
- accepted 18 December 2023

Abstract. The research paper aims to build a composite index of the financial performance of companies, to find if the impact of the COVID-19 crisis was significantly positive for most manufacturing companies listed on Bucharest Stock Exchange, and to look if the manufacturing companies were resilient being prepared with savings that could have mitigate the effects of this pandemic crisis. The results of the FE model selected show that 31.67% of the company's equity variation is justified by the two independent variables, the stronger correlation of equity being with reserves. Based on the composite index of financial performance built, the manufacturing companies were grouped in three clusters: a cluster with low financial performance companies ($z < 4$), a cluster with good financial performance companies ($4 \leq z \leq 8$) and a cluster with high financial performance companies ($z > 8$). The third cluster groups the most analysed companies, on which the pandemic crisis had a positive impact, which achieved the highest financial performance; they are those companies that "take advantage" from the COVID-19 crisis, adapting their business strategy to the market conditions imposed.

The article adds value to the specialty literature by building the financial performance's composite indicator, clustering the manufacturing companies by financial performance' Z-score.

Keywords: composite index, financial performance, principal component analysis, manufacturing companies, COVID-19, cluster.

JEL Classification: L25, L60, C38.

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1. Introduction

The company's performance will lead managers to make decisions in conditions of continuous activity, as well as in crisis situations, such as the COVID-19 pandemic. When a crisis occurs, managers tend to react emotionally and not see the solutions or opportunities opened by the extraordinary event (Kraus et al., 2020). That is why the company's management must prepare the company's activity precisely for unforeseen situations, such as the pandemic crisis. The company's response must be able to be an optimal one and refer to the reduction of operational activity costs, partially compensating for the reduction of revenues, through an on-going managerial strategy focused on the strategic renewal of the business and only as an extreme solution, closing the business (Wenzel et al. 2020).

Some of the studies carried out on companies listed on the Bucharest Stock Exchange (Dospinescu & Dospinescu, 2018; Sabău-Popa et al., 2021) evaluated and predicted financial performance using composite indicators, while other studies analyzed companies' performance including environmental, social and governance factors (Simionescu & Dumitrescu, 2018; Siminică et al., 2019; Vuță et al., 2019; Popa et al., 2022), and others examined the importance of non-financial information in the sustainable reporting of Romanian companies (Ibrescu & Hațegan, 2017; Man & Bogaeanu-Popa, 2020; Beleneși et al., 2021; Ionita & Dinu, 2021). In their research, investigating the degree of disclosure of information by Romanian companies in the agricultural and manufacturing industry, Ibrescu and Hațegan (2017) concluded that a small number of companies are aware of the importance of disclosing sustainability indicators, also highlighting that the highest degree of voluntarily disclosed information is for registered CSR in the food industry. In the study conducted by the authors Popa et al. (2022) is highlighted a direct connection between the ESEG index and the financial performance of Romanian companies.

The COVID-19 pandemic meant such a risk that affected – to a greater or lesser extent – Romanian companies and those worldwide. Are companies resilient being prepared with savings that can mitigate the effects of this pandemic? The influence of the pandemic crisis on the performance of companies has also been analyzed in specialized literature, some studies identifying a positive influence of COVID-19 on the performance of logistics companies (Atayah et al., 2022), others finding a negative correlation between the level of turnover and investments, respectively the influence of the pandemic crisis (Shen et al., 2020), many other studies finding instead a negative influence of COVID-19 on the financial performance of companies (Nguyen, 2022; Nyikos et al., 2021; Achim et al., 2022). But no study investigates whether they were prepared with savings that can mitigate the effects of this pandemic crisis. From this point of view, in our research, by investigating whether the manufacturing companies were prepared with savings to face any possible crises and clustering of the companies according to the effects of the pandemic crisis on their financial performance, we cover this research gap.

Companies in the manufacturing sector are generally more stable in terms of financial performance and have remained open during crises such of the pandemic or stock market type. Olczyk and Kuc-Czarnecka (2021) show in their research that the most companies that remained open during the pandemic crisis were those in the manufacturing sector, as opposed to those in the service sector, which were disadvantaged during this period. That's why we selected for our research only companies from production field and listed on the Bucharest Stock Exchange (BSE), which is an emerging market according to FTSE classification (FTSE Classification of Equity Markets, 2023).

In these conditions, our research approach to fill the research goal, aiming to answer to the following research questions:

- Q1.** *Whether is a link between equity and the protection of manufacturing companies listed on Bucharest Stock Exchange through provisioning and reserves? Are they resilient to the COVID-19 crisis?*
- Q2.** *How was the impact of COVID-19 for most manufacturing companies from an emerging market, from the point of view of the financial performance?*

This paper is structured in three sections, ending with conclusions on the analysis conducted, its limitations, and perspectives on further research. Section 2 presents a brief specialized literature review on the company's equity and the influence of the COVID-19 on companies' performance. Section 3 presents the data, the research methods ending with the empirical results. Finally, the research paper ends with conclusions and limitations of research.

2. Literature review

The specialized literature review was carried out following our research objectives, namely equity, the protection of the companies from possible risks/crises, and the influence of the pandemic on companies' financial performance.

The equity and research association with provisions and reserves has been a significant research interest, with over 100 scientific papers indexed in the Web of Science database since 2019. In their research, Milošević et al. (2020) identified a positive correlation between the level of equity and self-financing and the performance and sustainability of companies. Studying the influence of COVID-19 on the shares listed on the Chinese Stock Exchanges, Ren et al. (2021), show that the negative effects on the COVID-19 virus regarding the decrease in the market value of the analyzed companies are only temporary, for a maximum period of 1 month, and after that they return to normal market values.

Ding et al. (2021) reach the following conclusions following the empirical investigation through the multiple regressions performed: companies with less debt before 2020 and with good liquidity have a better evolution of their share price on the stock exchange in the context of the pandemic crisis; firms with international suppliers/customers experience a greater share price decline; companies with strong CSR activities before 2020 are more resilient to COVID-19; companies that have a management policy on hand better results in response to cases of COVID-19.

In the last three years, researchers worldwide have dedicated their attention to studying this topic- *Influence of COVID-19 on the company's financial performance*-, with 276 ISI scientific papers already being recorded in the WOS database in December 2022. Most of the ISI articles that study the influence of COVID-19 on the company's financial performance fall into the following areas of research: business (37%), management (19%), economics (17%), environmental studies (16%), Green Sustainable Science Technology (14%), Environmental Sciences (14%).

In their research, the authors analyzed the impact of the pandemic on the Chinese companies' performance, concluding that an increase in income and investments will reduce the negative impact of the Covid pandemic on the economic entity (Shen et al., 2020). Atayah et al. (2022) examine the impact of the pandemic on the financial performance of logistics companies in G20 countries. In the case of 14 of the analyzed countries, the authors find a positive impact of COVID-19 on the financial performance of analyzed companies, while in the case of 6 countries, including Germany and the UK, it was negative. Instead, Nguyen (2022) analyses the financial data of more than 100 logistics companies listed on the stock exchange in Vietnam and finds that during the pandemic financial performance measured by the return on assets, the turnover, and the level of leverage decreased. The same results

were reached by Nyikos et al. (2021) examining the performance of Hungarian companies during the pandemic.

How has the pandemic damaged the performance of companies? For example, if the activity of the companies had not been affected by the pandemic, would they have achieved different performances? These are questions that some researchers have tried to answer by analyzing the return on assets (ROA) and the leverage ratio (LEV) calculated as a debt/equity ratio (Rababah et al., 2020). Indeed, equity financing is preferred to external financing. However, along with adequate liquidity management, a high level of equity leads to the strengthening of the economic performance of the companies in terms of the return on assets (ROA) and the return on equity (ROE) held by the company (Achim et al., 2022). Measured by the ROA and ROE, the financial performance is positively affected by company liquidity (Nguyen & Nguyen, 2020) and significantly depends on the ratio of debt to equity, with debt being diminished in situations where companies have registered profit (Bătrâncea, 2021). Regarded as financial indicators of the company – Total Asset, Current Ratio, Return on Assets, Profit Margin, and Net Profit Margin – the effects of the COVID-19 pandemic on companies on Industry classification were subjected to study, most of them being in the industry field (Ren et al., 2021).

Nevertheless, the financial and innovative performance of the companies can take different forms in the situation of companies financed with equity capital (Hornuf & Schwienbacher, 2017, 2018), with the inherent influences of the heterogeneity of shareholders, compared to the companies that used other sources of financing (Walthoff-Borm et al., 2018).

Regarding the factors influencing the performance analysis indicators, Lin et al. (2022) treat financial performance alongside ESG, bond financing, and the COVID-19 as significant factors influencing companies' business. Their study concludes that in terms of financial performance, the determining factor is the gross profit margin rather than the return on equity. Similarly, Xu et al. (2021) examine the ESG performance of Chinese listed companies, concluding that R&D investment significantly and positively influences green innovation performance. Xie et al. (2019) demonstrate in their study that exist a moderate positive relationship between companies' ESG reporting and their performance, while the relationship between governance reporting and corporate effectiveness is positive and strong.

The fluency of the COVID-19 pandemic was felt in all fields of activity, which determined that the scientific research activity should consider the analysis of its influence on companies' performance. Much of this research focuses on the business model of companies (Song et al., 2022; Mattera et al., 2022), competitive advantages (Ilinova et al., 2021; Yu, 2022), and strategies that allow companies to overcome their competitors in the field of activity (Porter, 1997; Marom & Lussier, 2021) or the managerial ability to overcome periods of crisis (Kumar & Zbib, 2022).

Many papers, such as those of the authors: Boloş et al. (2019a, 2019b), Kropat et al. (2016, 2020), used the fuzzy techniques to modeling the performance indicators of the companies, these models should be used especially when dealing with uncertainty, ambiguity or lack of data. For example, in their paper the authors Kropat et al. (2020), propose several mixed models based on fuzzy coefficients, neural networks and regression techniques, which can be used for the analysis and prediction of eco-financing networks or regulatory systems.

Other authors, such as Aslam et al. (2019), Aslam and Albassam (2019), Khalilpourazari et al. (2019), Tirkolaei et al. (2020), Kalaycı et al. (2020), Savku and Weber (2018) in their researches combine fuzzy theory with mathematical programming thus obtaining hybrid models, or use stochastic differential equations, for optimizing the variables associated with a company's performance indicators.

Using SPSS statistics and a five-point Likert scale, Barbu et al. (2021) analyze the perception of organizational performance. They formulate hypotheses about a positive correlation between organizational performance and financial dimension, age and size of companies, management experience, level of organizational innovation, quality of services, and business excellence models. In their research paper, Sabău-Popa et al. (2021), using principal components analysis have built composite financial index for measuring companies' performance and then have predicted the financial performance with the neural networks' technique. In fact, the present research also used principal component analysis (PCA). This method of analysis was developed by Pearson (1901) and has been analyzed over several decades (Hotelling, 1933; Jolliffe, 2002).

Our findings from this article are in line with those of Achim et al. (2022), Ilinova et al. (2021), Kumar and Zbib (2022), Kropat et al. (2020), and Tirkolaei et al. (2020). Our contribution to the literature is concrete in building the financial performance's composite indicator, in grouping the analyzed companies into three clusters, according to the COVID-19 impact on their financial performance reported to the 2019–2020 timeframe, and in highlighting the importance of the strategy of managers in preparing companies for a possible crisis. The novelty and the originality of our study relies on the different approach of evaluate if the companies were prepared with savings that can mitigate the effects of this pandemic crisis, on the proposed composite index of the financial performance of manufacturing companies and on clustering the companies listed on BSE according to the COVID-19 impact on their financial performance reported to the 2019–2020 timeframe.

3. Empirical analysis

3.1. Data

In this paper, we analyzed the annual financial-accounting data published by 34 manufacturing companies listed on the Bucharest Stock Exchange for the period 2017–2020. The data source is the BVB website and the financial statements of the analyzed companies. In our research, we sought to identify the following causal relationships and to answer two hypotheses related to the performance of the companies in the field of production listed on the Bucharest Stock Exchange (BSE):

- H1.** *There is a significant correlation both between reserves and equity, and between provisions and equity.*
- H2.** *COVID-19 crisis had a significant impact, positive or negative, on financial performance of the manufacturing companies listed on emerging market.*

As a result of the aspects mentioned in the previous sections, we analyzed the following relevant variables to highlight the companies' performance levels and in order to include

them in the composite index of financial performance: the return on assets, the return on equity, the current liquidity ratio, and the solvency rate. In addition, we will also describe the following variables: the equity, the reserves and the provisions, and analyzed the relationship between them.

The descriptive statistics variables are summarized in Table 1 (The minim, maxim, and mean values for the equity, the provisions, and the reserves are in RON).

The Return on assets (ROA= Net profit*100/total assets) measures the overall performance of the company's management in generating profit using the assets held. The financial indicator returns on assets ranged between -17.83 and 29.24 , with a mean of 3.90 . In Figure 1, we show the average ROA in the case of the analyzed companies, the average band of ROA of all companies being highlighted in light grey.

We note that the highest average asset performance was recorded by Prodvalco SA (VAC), closely followed by Zentiva SA (SCD) and Biofarm SA (BIO). At the opposite pole, are the manufacturing companies in which case no return on assets was recorded, and some even increased their net loss in 2020, under the impact of the COVID-19 pandemic, such as Sinteza SA (STZ), Uztel SA Ploiesti (UZT), Altur SA (ALT), Electroaparataj SA (ELJ).

The Return on equity (ROE = Net profit*100/equity) outlines the net profit relative to the company's equity, the performance of the investment made by shareholders by buying the company's shares. The return on equity ranged between -52.80 and 41.64 , with a mean of 5.92 and an average deviation from the mean value of 12.41 .

In Figure 2, we showed the average ROE in the case of the analyzed companies, the average band of ROE of all companies being highlighted in light grey. We note that the highest average equity performance was recorded by Prodvalco SA (VAC), closely followed by IAR SA (IARV), Zentiva SA (SCD), and Aerostar SA (ARS).

At the opposite pole, are the companies in which no return on the use of equity was recorded. Some even increased their net loss in 2020, due to the COVID-19 pandemic, such as Altur SA (ALT), Sinteza SA (STZ), Uztel SA Ploiesti (UZT), Electroaparataj SA (ELJ), actually the same companies that didn't record performance in using assets.

The current liquidity ratio (RLC = Current assets/current liabilities) showed the company's ability to pay its short-term debts from the short-term assets. It is calculated as the ratio between current assets and short-term liabilities. The current liquidity ratio ranged between 0.49 and 14.85 , with a mean of 2.97 , according to the data from Table 1.

Table 1. Descriptive statistics (source: authors' calculation)

	Minimum	Maximum	Mean	Std. deviation
Equity	8800000.00	140000000.00	174358823.53	221299587.95
Provisions	0.00	130000000.00	8377484.49	23544044.10
Reserves	36480.00	320000000.00	54305444.50	77921403.69
ROE	-52.80	41.64	5.92	12.41
ROA	-17.83	29.24	3.90	7.49
RLC	0.49	14.85	2.97	2.59
RSG	0.85	25.17	4.66	3.37

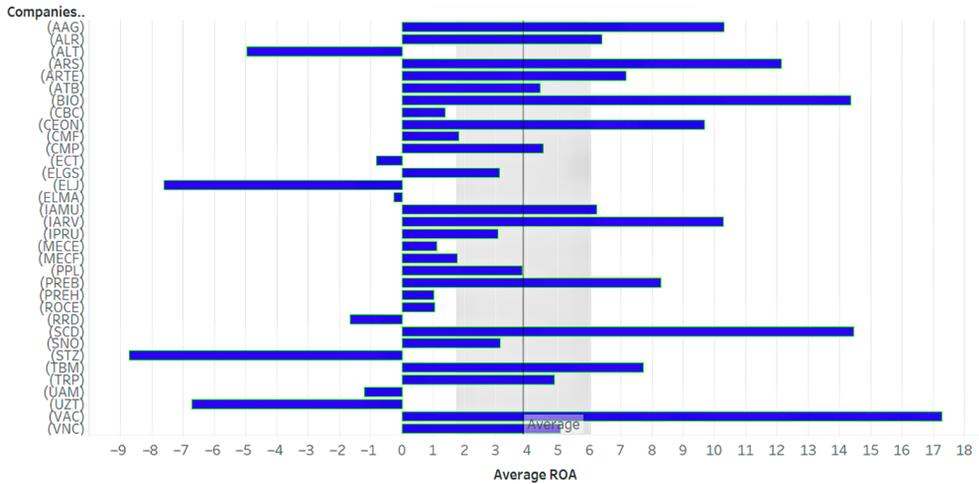


Figure 1. The average ROA for the period 2017–2020 (source: authors processing with Tableau 2022.2)

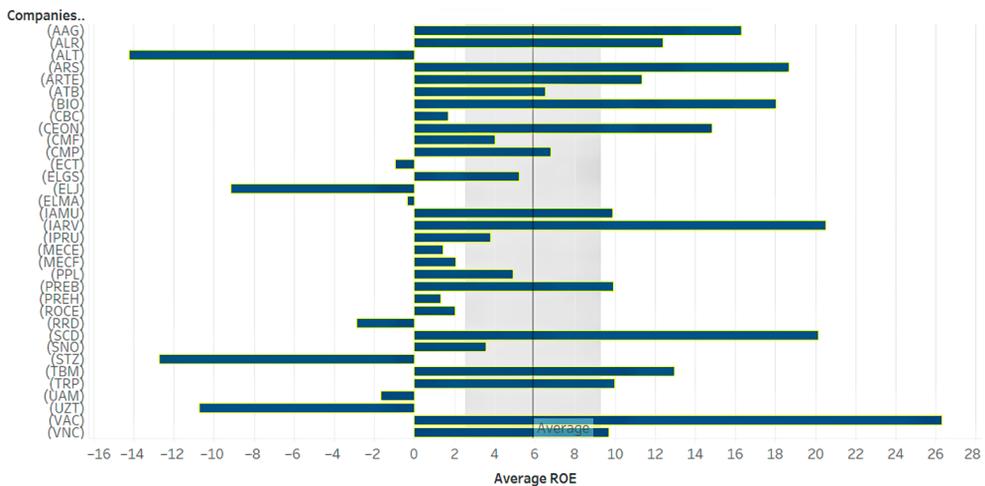


Figure 2. The average ROE for the period 2017–2020 (source: authors processing with Tableau 2022.2)

In Figure 3, we showed the average current liquidity ratio in the case of the analyzed companies, the average band of RLC of all companies being highlighted in light grey. The recommended acceptable value in the case of RLC is around 2.0 and provides the guarantee of covering current liabilities from current assets. We note that the following companies have very good current liquidity, above average: Aerostar SA (ARS), Santierul naval Orsova (SNO), Mecanica Ceahlau SA (MECF), Electroaparataj SA (ELJ), Prebet Aiud SA (PREB), Zentiva SA (SCD), Biofarm SA (BIO). The following companies have average current liquidity below the optimal level, which shows us that they may have difficulties in managing the treasury in the short term: Mecanica Fina SA (MECE), Prefab SA (PREH), Romcarbon SA Buzau (ROCE), Comelf (CMF), ELGS, Sinteza SA (STZ), Altur SA (ALT).

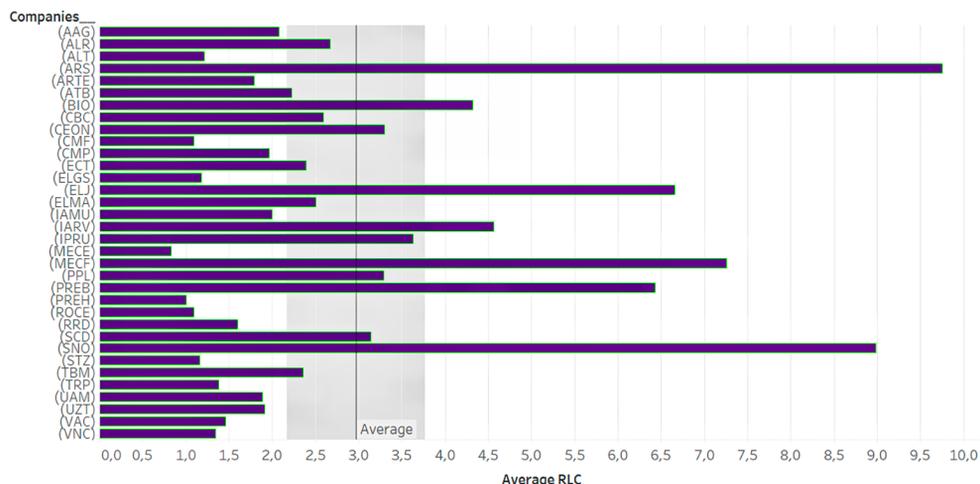


Figure 3. The average RLC for the period 2017–2020 (source: authors processing with Tableau 2022.2)

The general solvency ratio ($RSG = \text{total assets}/\text{total liabilities}$) shows the company's ability to pay its debts from its assets, with the recommended minimum value being 1. All companies recorded a good average solvency ratio, over 1.8 during the analyzed period. The solvency ranged between 0.85 and 25.17, with a mean of 4.66, according to the data from the Table 1. The following companies registered general solvency over average during the analyzed period: Prebet Aiud SA (PREB), Carbochim SA (CBC), Biofarm SA (BIO), Turbomecnica SA (TBM), Mecanica Ceahlau SA (MECF), Santierul naval Orsova (SNO), Aerostar (ARS), Electromagnetica SA (ELMA), Mecanica Fina SA (MECE), SC Grupul Industrial Electrocontact SA (ECT), Electroaparataj SA (ELJ), Iproeb SA (IPRU).

The companies' equity includes, mainly, the net result, the reserves, the provisions, retained earnings, share capital, revaluation reserves. The company's equity ranged between 1.796.000 Euro and 285.727.000 Euro, with a mean of 35.583.400 Euro. All companies analyzed have recorded legal and other reserves, and most companies have made provisions for employee benefits and other provisions. The following companies did not set up provisions or only had them in 2017: Artego SA (ARTE), Prefab SA (PREH), Iamu SA (IAMU), SC Grupul Industrial Electrocontact SA (ECT), UAMT SA (UAM).

3.2. Methods

Analysis was conducted in three steps, starting with the relationship between the equity, on the one hand, and the reserves and provisions, on the other hand. This first step was followed by constructing a composite index through principal component analysis. Then, based on the composite index, data were grouped into three clusters, and companies were classified according to their financial performance during the COVID-19 timeframe. The analysis was performed using dedicated statistical software SPSS24 and STATA64.

The variables were structured in panel data over a timeframe of four years. Panel data is appropriate when are observed the same units in different periods (Kennedy, 2008). Panel

data is preferred to cross-sectional or time series analysis because it offers more informative data, more variability, efficiency, and less collinearity among variables (Baltagi, 2001). Panel models deal with fixed and/or random effects in the longitudinal data. The main difference between the two models is in the role of the dummy variables: in a FE model is part of the intercept, while in a RE model is an error component. The mathematical equations of the one-way fixed and random effects models are:

Fixed effect model: $y_{it} = (\alpha + u_i) + X'_{it} \beta + v_{it}$, and

Random effect model: $y_{it} = \alpha + X'_{it} \beta + (u_i + v_{it})$,

where u_i is a fixed or random effect specific to an individual or time frame that is not included in the regression.

The Hausman specification test (Hausman, 1978) is performed to compare a random effect model to its fixed counterpart. The null hypothesis states that the preferred model is random effects. F-test tests a fixed effect model under the null hypothesis that all dummy parameters except for one are zero. A random effect model used the Lagrange Multiplier test of Breusch and Pagan (1980), which examines if the individual or time-specific variance components are zero.

Principal component analysis (PCA) is used in the case of large datasets to explain the variance-covariance structure of the variables through a few linear combinations of the initial variables to reduce data and ease the interpretation (Johnson & Wichern, 2007). All the variables explain the full variability of the model, but a small number of components can account for much of it. So, the new model will explain an essential quantity of the initial variability through a few principal components. The first component will account for the most variability of the initial system, the second for a smaller quantity but most of the remaining, and so on. The second component is not correlated to the first one. The choice of the appropriate number of components to be held is made through several criteria, among which is Kaiser's criterion (1960), which emphasizes keeping the components with a corresponding eigenvalue greater than unity. Finally, a visual inspection of the scree plot would suggest retaining the components until a significant drop is observed in the eigenvalues.

The principal component analysis is used as an intermediate step. In this case, the purpose is to create a composite index that will cluster the analyzed companies based on their financial performance during COVID-19 pandemics.

Financial data may offer different aspects and come in different units, so a pre-step of the principal component is to converge all variables to a common unit. This process is called standardization, and it assumes a normalization of the variables (x_{ij}) under a common normal distribution by subtracting the average (x_j) and dividing by its standard deviation (σ): $Z_{ij} = (x_{ij} - x_j)/\sigma$,

The statistical tool used to classify the manufacturing companies listed on BSE according to their performance is cluster analysis. This exploratory analysis works to group cases if the grouping is not previously known. The grouping approach used in this case is hierarchical clustering, in which the closest data are grouped to form a cluster, and the process is repeated until all observations are distributed. The optimal number of clusters is chosen out of all cluster solutions.

3.3. Empirical results and discussions

The first step of the analysis determined if the provisions and the reserves can explain the company's equity.

Table 2 offers the first hint of a significant relationship, with a strong relationship between reserves and the company's equity and a lower intensity relation between the company's equity and provisions.

Table 2. Correlation matrix of equities, provisions, and reserves (source: authors' calculation)

		Equity	provisions	reserves
EQUITY	Pearson correlation	1	0.285**	0.839**
	Sig(2-tailed)		0.001	0.000
PROVISIONS	Pearson correlation	0.285**	1	0.400**
	Sig(2-tailed)	0.001		0.000
Reserves	Pearson correlation	0.839**	0.400**	1
	Sig(2-tailed)	0.000	0.000	

Note: **. Correlation is significant at the 0.01 level (2-tailed).

The panel data regression model used for analysis the correlation between equity, reserves and provisions is a Fixed Effect Model. The choice of the regression type was made based on Hausman specification test, because P-Value is 0.000 less than 0.05 which means the best method to use is fixed effect, as can be seen in the Table 3.

Table 3. Hausman specification test (source: authors' calculation)

	Coefficients (b)FE (B) RE	(b-B) difference	Sqrt (diag (V_b-V_B)) SE
Provisions	3.8019 1.3013	2.5005	1.4065
Reserves	0.6025 1.6762	-1.0737	0.2477
Chi2 (2) = 33.79; Prob > chi2 = 0.000			

An increase with 1 unit in reserves will lead to an increase with 0.60 units in the company's equity. As can be seen in the Table 4, prob (F-Statistic) is below the 5% significance level, so can say that our FE model is valid. Moreover, due R-squared value, we can say that 31.67% of the equity variation is justified by the two independent variables of the selected FE model, i.e., reserves and provisions.

Table 4. Fixed effect model parameters (source: authors' calculation)

Equity	Coef	Std. Err.	t	P > t	[95% Conf Interval]
Reserve	0.6025	0.3300	1.83	0.071	-0.0523, 1.2572
Provisions	3.8019	1.6204	2.35	0.021	0.5869, 7.0168
Cons	1.10	2.48	4.43	0	6.08, 1.59
F test that all u_i = 0: F (33, 100) = 13.95					

Note: Prob > F = 0.000.

So, considering what is presented in the previous tables, we can say that there is a strong positive correlation between reserves and equity, but a very weak correlation between provisions and equity. This shows that the manufacturing companies have set up reserves because of their net profit, thus being resilient to unforeseen events such as the COVID-19 crisis. Thus, we can say that hypothesis H1 is confirmed only for its first part, i.e., the significant and positive correlation between reserves and equity.

The second step of the analysis consists of creating a composite index to measure the manufacturing companies' financial performance on BSE. All variables were previously standardized.

In Table 5 are presented the eigenvalues, and the proportion of variance explained through each component individually and cumulated. The first component accounts for 50.93% of the total variability of the system, while the first two components together explain 90.3% of it. Since the variability explained through the first two components is high and accounts for the majority, a suitable choice of the number of components to hold in the model would be two.

Table 5. Eigenvalues of PCA and corresponding proportion of variance and KMO test (source: authors' calculation)

Component	Eigenvalue	% of Variance	Cumulative%
1	2.03738	50.93	50.93
2	1.57482	39.37	90.3
3	0.35425	8.86	99.16
4	0.033551	0.84	100

KMO = 0.495; *p*-value = .000.

Based on Kaiser's criterion (Kaiser, 1960), the eigenvalues are more significant than unity for the first two components.

The scree plot in Figure 4 also suggests two components to describe the model, whereas they have values that were close to zero. Thus, this mean that the first component explained 50.93% of the information, and the second component 39.37%.

The nature of each principal component was determined within the coordinates system of the two components presented in Figure 5. Component 1: *return rates* is strongly correlated to the ROA and ROE indicators of the analyzed companies and describes the efficiency of a company using its resources to generate profit (Sabău-Popa et al., 2020). This component displayed the return rates component related to the financial performance of manufacturing companies.

The second component: *liquidity rates*, is mainly correlated to RLC and RSG, and it can be described as the ability of the company to pay its obligations, both long-term and short-term, from the assets held.

Table 6 presents the coefficients of the linear combinations that define the functions of the two components:

$$C1 (\text{Return rates}) = 0.6487*ROE+ 0.6541*ROA+ 0.2978*RLC+0.2502*RSG;$$

$$C2 (\text{Liquidity rates}) = -0.2828*ROE- 0.2647*ROA+0.6378*RLC+ 0.6657*RSG.$$

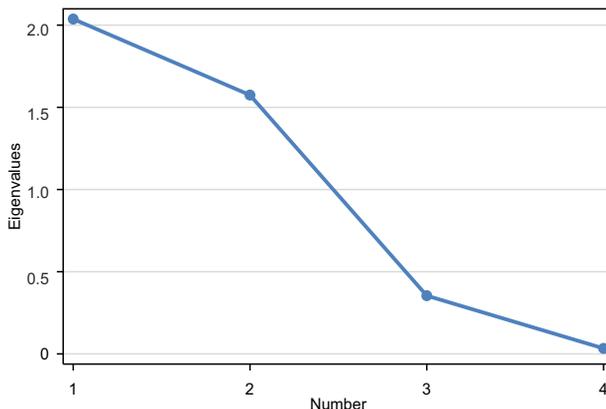


Figure 4. Scree plot of eigenvalues after PCA (source: authors’ calculation)

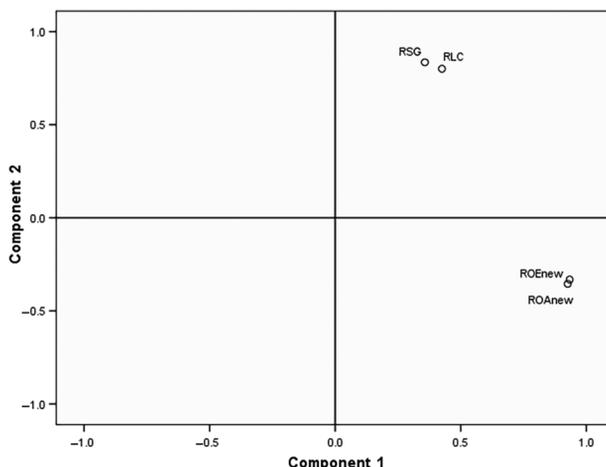


Figure 5. Component plot for the first two components (source: authors’ calculation)

Table 6. Principal components factors (source: authors’ calculation)

Variable	Return rates	Liquidity rates
ROE	0.6487	-0.2828
ROA	0.66541	-0.2647
RLC	0.2978	0.6378
RSG	0.2502	0.6657

The two components account for a majority of 90% of the total variability of the initial system and can be summarized in a single index:

$$Z \text{ score} = 0.3659 \cdot ROE + 0.3894 \cdot ROA + 0.9356 \cdot RLC + 0.9159 \cdot RSG.$$

The composite index Z is used to classify companies based on their financial performance, namely:

- if $the\ Z\text{-score} < 4$, the companies are classified as one with a low financial performance, with insufficient levels of financial performance, liquidity, or solvency. In this category are seven companies.
- if $4 \leq Z\text{-score} \leq 8$, the companies are considered to have a good financial performance, with a sufficient level of the return on assets, the return on equity, and a good liquidity. In this category are most of the analyzed companies.
- if $Z\text{-score} > 8$, the companies have outstanding financial performance, with a very good level of all the variables analyzed. In this category are nine companies.

The company's average level of financial performance is presented in Figure 6, with the highest result on Aerostar SA (ARS), closely followed by Șantierul naval Orșova (SNO) and Prebet Aiud SA (PREB). The lowest level of the average Z-score was touched by the company Altur SA (ALT), closely followed by Comelf (CMF) and Electroargeș SA (ELGS). Over 40% of the companies' average Z-scores range around 5.

Finally, the companies are classified and clustered based on the previously created index, Z-score, depending on the difference between the Z score obtained by the company in 2020 and the one related to 2019.

In other words, the manufacturing companies listed on BSE are clustered according to the COVID-19 impact on their financial performance reported to the 2019–2020 timeframe, as can be seen in the Figure 7:

- The first cluster contains companies with a difference Z-score lower than -0.5 . The pandemic crisis had a negative impact on the financial performance of these companies (there are 7 companies in these cluster);
- The second cluster consisted of companies with a difference Z-score ranging between -0.5 and 0.5 . Here are included the companies on which the pandemic crisis had no significant impact on their financial performance (there are 12 companies in these cluster); these are the companies that showed resilience to the COVID-19 crisis;
- The third cluster includes the companies with a difference Z-score above 0.5 , those companies on which the pandemic crisis had a positive impact (most of the analyzed companies are in these cluster); these are the companies that 'take advantage' from the COVID-19 crisis, adapting their activity and registering an increase in the level of financial performance.

Thus, we can say that hypothesis H2 is partially confirmed for most of the analyzed companies (65%).

With the lowest level of financial performance are clustered seven companies, among these being: Electroaparataj SA (ELJ), Altur SA (ALT), Uztel SA Ploiesti (UZT), Turbomecanica SA (TBM), Sinteza SA (STZ). The companies from the first cluster were unprepared for the pandemic crisis, had insufficient reserves and provisions, and did not adapt their business strategy to the market conditions imposed by COVID-19.

In the second cluster are grouped the companies stable in terms of financial performance, on which the COVID-19 crisis had no significant influence, among these being the following companies: Romcarbon SA (ROCE), Electroargeș SA (ELGS), Vrancart SA (VNC), IAR SA (IARV), Iamu SA (IAMU). These companies had established significant reserves and provisions, they had sufficient fixed and current assets to allow them to overcome the crisis imposed by the COVID-19 pandemic, even in the conditions of the reduction in the volume of activity reflected by the reduction in turnover and net profit recorded for the year 2020.

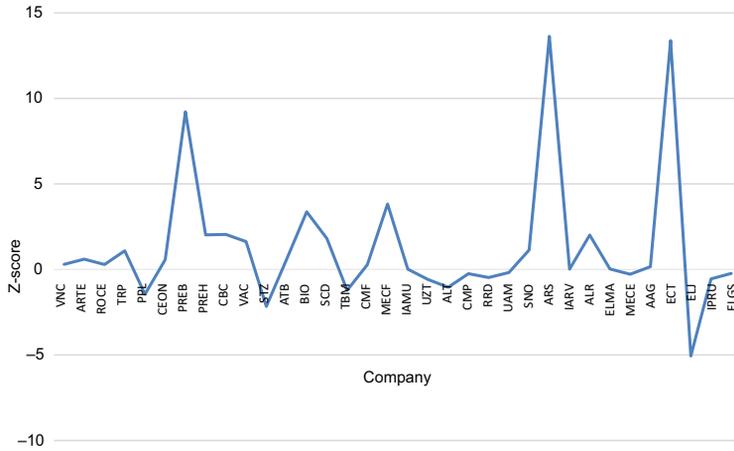


Figure 6. The company’s distribution based on average Z-score on the period 2017–2020 (source: authors’ calculation)

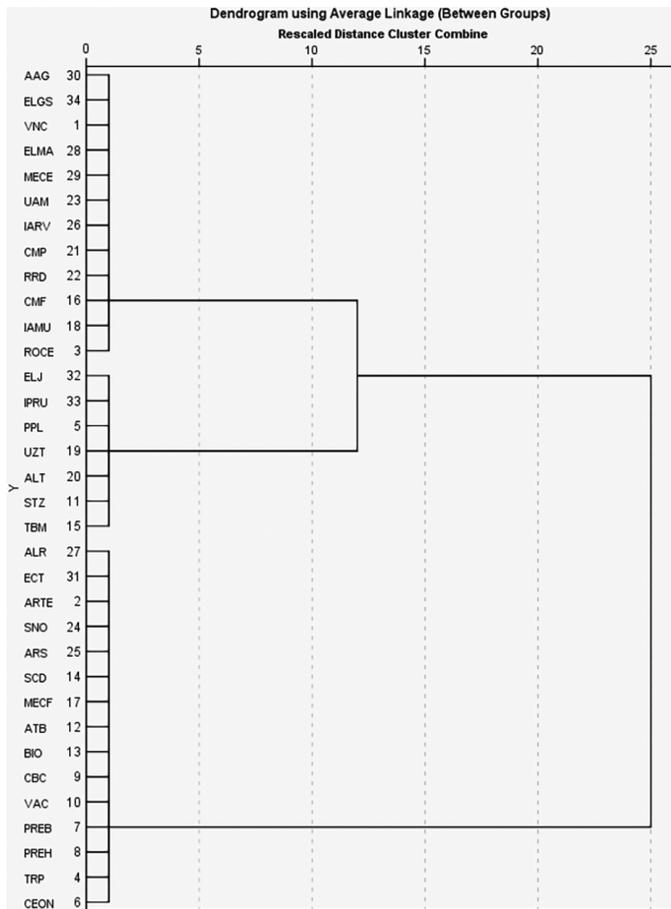


Figure 7. Dendrogram (source: authors’ calculation)

Most of the analyzed manufacturing companies, grouped in the third cluster, achieve the highest financial performance, among these being the following companies: Aerostar SA (ARS), SC Grupul Industrial Electrocontact SA (ECT), Prebet Aiud SA (PREB), Biofarm SA (BIO), Șantierul naval Orșova (SNO) and Alro SA (ALR). We notice that they are the same companies classified as having a very good financial performance, according to the average value of the Z- score for the period 2017–2020. They are actually those companies that adapted their business strategy to the market conditions imposed by the COVID-19 pandemic, and thus recorded in 2020 compared to the previous year and/or the increase in turnover, and/or the reduction of debts, which enabled the achievement of higher financial performances in 2020 versus 2019.

4. Conclusions and outlook

This research aims to build a financial performance's composite index, to find if the impact of COVID-19 was significant positive for most manufacturing companies, and to look if the manufacturing companies were resilient being prepared with savings that could have mitigate the effects of this pandemic crisis.

The analysis was conducted in three steps, starting with the relationship between the company's equity, on the one hand, and the reserves and provisions, on the other hand. The results of the FE model selected show that 31.67% of the company's equity variation is justified by the two independent variables, the stronger correlation of equity being with reserves.

This first step was followed by constructing a composite index of financial performance through principal component analysis, in order to classify the companies in three categories, according to the value of the average Z-score: companies with low financial performance ($z < 4$), companies with good financial performance ($4 \leq z \leq 8$) and companies with high financial performance ($z > 8$). Both components of the financial performance index contributed directly and positively to it, the largest contribution of 50.93% being from the first component- return rates.

Then, based on the composite index, data were grouped into three clusters, and companies were classified according to their financial performance during the COVID-19 timeframe, in the last 2 clusters being included more than 75% of the analyzed companies. In the second cluster are included those companies that showed resilience to the COVID-19 crisis and on which the pandemic crisis had no significant impact on their financial performance. The third cluster groups the most analyzed companies, on which the pandemic crisis had a positive impact, which achieve the highest financial performance, both in 2020 and on average over the analyzed period. The companies from the third cluster are the same that was classified as having a very good financial performance, according to the average value of the Z- score for the period 2017–2020. They are those companies that "take advantage" from the COVID-19 crisis, adapting their business strategy to the market conditions imposed by the COVID-19 pandemic, and thus recorded in 2020 compared to the previous year and/or the increase in turnover, and/or the reduction of debts, which enabled the achievement of higher financial performances in 2020 versus 2019.

Our contribution to the literature is concrete in building the financial performance's composite indicator, in grouping the analyzed companies into three clusters, according to the COVID-19 impact on their financial performance reported to the 2019–2020 timeframe, and in highlighting the importance of the strategy of managers in preparing companies for a possible crisis. The novelty and the originality of our study relies on the different approach of evaluate if the companies were prepared with savings that can mitigate the effects of this pandemic crisis, on the proposed composite index of the financial performance of manufacturing companies and on clustering the companies listed on BSE according to the COVID-19 impact on their financial performance reported to the 2019–2020 timeframe.

The financial performance's composite indicator can be an instrument for the company's managers that can build the future strategies of performance optimization. At the same time, by building the composite performance indicator and grouping the analyzed companies into three clusters, we support the investors by showing them which companies in the production sector are stable in terms of financial performance.

The limits of our research can be found in a medium sample of manufacturing companies and the data collected from 2017 to 2020. The results invite us more in-depth research, with more companies from more sectors of activity and over a longer period of analysis, what it might lead to more robust models.

Acknowledgements

The research has been funded by the University of Oradea, within the Grants Competition "Scientific Research of Excellence Related to Priority Areas with Capitalization through Technology Transfer: INO–TRANSFER–UO–2nd Edition", Project No. 230/28.10.2022.

Funding

The publication fee for this article is supported by the scientific research budget of University of Oradea.

Author contributions

DSP, LR, AF conceived the study, LR, OIB, SD collected data, DSP and AOM designed the research methodology and developed the first analysis of the data. DSP, LR, AF and MO were responsible for data interpretation and discussion of results. MO, LR, AF wrote the first draft of the article. DSP, LR, OIB and SD wrote the second draft of the article. All authors have read and agreed to the published version of this article.

Availability of data

The data presented in this study are available on request from the corresponding author.

Disclosure statement

Authors do not have any competing financial, professional, or personal interests from other parties.

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