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Classification of Financial Ratios for BIST Manufacturing Sector Companies By Principal Axis Factor Analysis

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ABSTRACT

It can be said that financial analysis is an unavoidable requirement for companies. A company's board of directors, investors, creditors and anyone else interested in the company can use financial analysis to reveal the true financial position of the company. There are various methods for financial analysis, the most common of which is the analysis of financial ratios. There are many financial ratios in the literature and many of them are correlated. It is more advantageous for statistical analyses to derive a small number of new variables that explain a large portion of the variance of an aggregate of variables. This study aims to classify financial ratios for BIST Manufacturing Sector Companies using principal axis factor analysis and express them as new independent variables. As a result, five factors were extracted using principal axis factor analysis method and 22 financial ratios were distributed to these five factors. By reading the factor saturation results, it was determined that the number of saturated financial ratios appropriate for the sample size was 16 financial ratios.

BIST İmalat Sektörü Şirketleri için Finansal Oranların Temel Eksen Faktör Analizi ile Sınıflandırılması

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ÖZ

Finansal analizin şirketler için kaçınılmaz bir gereklilik olduğu söylenebilir. Bir şirketin yönetim kurulu, yatırımcıları, alacaklıları ve şirketle ilgilenen diğer herkes, şirketin gerçek mali durumunu ortaya çıkarmak için finansal analizlerin sonuçlarını kullanabilir. Bir şirketle ilgili finansal analiz ortaya koymak için; finansal tablo kıyaslaması, dikey analiz ve trend analizi gibi yöntemlerin yanısıra en yaygın yöntem olarak finansal oranlar analizi kullanılmaktadır. Çalışmada finansal oranlar analizi ele alınmıştır. Literatürde birçok finansal oran vardır ve bunların birçoğu birbiriyle ilişkilidir. Bir değişkenler toplamının varyansının büyük bir kısmını açıklayan az sayıda yeni değişken türetmek istatistiksel analizler için daha avantajlıdır. Bu çalışmanın amacı, temel eksen faktör analizi kullanarak BIST İmalat Sektörü Şirketleri için finansal oranları sınıflandırmak ve bunları yeni bağımsız değişkenler olarak ifade etmektir. Sonuç olarak, temel eksen faktör analizi yöntemi kullanılarak beş faktör çıkarılmış ve 22 finansal oran bu beş faktöre dağıtılmıştır. Faktör doygunluk sonuçları okunarak örneklem büyüklüğüne uygun doymuş finansal oran sayısının 16 finansal oran olduğu tespit edilmiştir.

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INTRODUCTION

Financial management is of vital importance for businesses as it deals with the methods of raising funds for companies and making the best use of these funds. The success of financial management means the success of businesses. One of the most important functions of financial management is the financing function. The finance function includes financial analysis, financial planning, financial auditing, provision and investment of funds and other important financial issues (Düzer, 2008).

Financial analysis is one of the most important methods used by business decision-makers to reach a fair decision about the financial status of the company. Business managers know the impact and effectiveness of financial decisions made through the analysis of financial statements. In addition, it is a necessity for those who want to invest in a company to learn the financial status of the company and this can only be achieved by examining the financial analysis (Aypar, 2010).

Financial analysis is defined as the study of the financial position of a business over a period of time in order to obtain information that is used for decision making and evaluation of the past and present performance of commercial and industrial enterprises (Dalak et al., 2018). There are multiple techniques to obtain an analysis of the financial statements and hence achieve the desired benefit, to know the current state of the business and to predict its future performance. The most common of these is ratio analysis, which is most commonly used in measuring the financial performance of companies (Kizil & Aslan, 2019). Financial ratios analysis helps stock investors and lenders to determine the position of the company, its profitability and the expected risks it faces in the market (Jashan, 2022). Financial ratios can be defined as dividing the balance items by each other or by some items in the income statement to obtain a result showing the strengths and weaknesses of the company (Savsar, 2012).

Financial ratios may be correlated with each other, making them less efficient in obtaining the desired information. Correlated variables cause problems in multivariate statistical techniques such as regression analysis. To reduce the influence between groups of financial ratios, it is possible to uncover hidden factors in a set of financial ratios. Factor analysis is one of the most common methods for extracting hidden factors in a data set (De, 2011). In this study, financial information of the firms traded in the BIST manufacturing sector was obtained and a classification was performed for financial ratios through principal axis factor analysis, one of the factor derivation techniques. As a result of the classification, it is aimed to express financial ratios as independent new variables for BIST manufacturing sector companies.

1. REVIEW OF LITERATURE

When past studies on financial ratio analysis and factor analysis applied in this field are reviewed, the findings given in Table 1 can be summarized as follows:

Table 1. *Studies on financial ratios using factor analysis*

Researcher	Year	Information about the study
Puri et al.	2022	This paper concludes with a discussion of how financial performance can be assessed using only some ratios, rather than examining a large number of ratios, which can be confusing. Since the ratios are all derived from the same tables and are interrelated, researchers have been able to use some ratios to represent others with little loss of information.
Janićijević et al.	2022	According to the study, 14 financial ratios can be grouped under seven factors and reflect about 86% of the variance of the study data.

Researcher	Year	Information about the study
Mazhar	2022	In this study, companies in various sectors were taken into consideration and grouped by principal component analysis among the financial ratios in the literature. Financial ratios that are more meaningful according to the sectors are revealed.
Sabau-Popa et al.	2020	The study concluded that the seven financial ratios can be grouped into three factors that explain 72% of the data for the companies studied.
Mbona & Yusheng	2019	The authors conclude by showing how 12 ratios can be used to assess financial performance, rather than costly analysis of a large number of ratios that can be difficult to understand.
Damani et al.	2018	After three rounds of factor analysis, the researchers found that 50 financial ratios can be reduced to three representative ratios for companies in the Indian IT sector.
Taspinar Cengiz et al.	2015	In the study, using factor analysis method, it was concluded that 24 financial ratios can be grouped under 6 factors. Using the discriminant method, it was observed that an increase in the eigenvalues of the factors for the companies examined predicts the probability of failure, while a decrease predicts the probability of success.
García Jara et al.	2011	As a result of the study, there is evidence that the quality of financial information is influenced by accounting standards. In addition, there are a number of factors that suggest an alternative way of analyzing financial information.
De	2011	The study concluded that 25 financial ratios can be reduced to 8 factors and that these ratios can be relied upon when analyzing the financial performance of the companies studied.
Kalayci & Karatas	2005	The aim of this study is to reveal the relationship between stock returns and financial ratios. According to the sectors; regression analysis was applied to examine whether there is an effect between the factors obtained by factor analysis of financial ratios and stock returns. In addition to the regression models using direct financial ratios, the regression coefficients obtained with factor values are also significant.
Keskin Benli	2005	In 2002, analysis of variance was applied to determine whether there are sectoral differences in the financial ratios of industrial companies traded on the Istanbul Stock Exchange. In addition, it was concluded that 27 of the 36 financial ratios can be classified by factor analysis and that sectoral differences have statistically significant differences on financial ratios.
Güneren	2003	This study measures the impact of the 2001 crisis on 178 firms in 13 different sectors by analyzing their financial statements before and after the crisis. After using 21 financial ratios and applying factor analysis, it is seen that these ratios are grouped under 8 factors. The study also concludes that before the crisis in February 2001, companies in different sectors were divided into two groups, while after the crisis in February 2001, most of the companies were divided into one group. This is due to the damage caused by the crisis and the fact that this damage led most of the companies to merge into a single cluster. This is also confirmed by the analysis of profitability ratios and it is observed that the crisis had a negative impact on the profitability of companies.

Researcher	Year	Information about the study
Yli-Olli & Virtanen	1990	The study concludes that the 12 financial ratios analyzed fall under four factors and that this classification based on empirical data is not fully equivalent to previous classifications.
Chen & Shimerda	1981	This study has shown that a significantly reduced number of factors can be used to classify the financial ratios examined in previous studies on bankruptcy prediction.

Most of the studies have been interested in investigating the impact of financial ratios on stock returns, predicting stock returns, and their role in determining stock trends. Other studies have focused on the relationship between financial ratios and profitability and the measurement of the financial performance of companies or organizations.

In addition, financial ratios are considered as dependent and independent variables together with many other variables such as inflation, company value, company profit or loss. In addition, logistic regression analysis and panel data analysis are the most frequently used methods for analyzing financial ratios with other variables in most of the studies examined. In studies similar to the subject of this study, principal component analysis, which is one of the factor derivation techniques of factor analysis, is frequently used.

2. FINANCIAL ANALYSIS

Financial management aims to maximize the market value of an enterprise. In the light of the information contained in the financial statements; variables affecting the market value can be revealed. Thus, financial statements provide clues about the effects of financial and administrative decisions on the performance and risk of the enterprise.

Financial analysis is a process used to know the status of the organization in order to make administrative decisions or investment and credit or lending decisions in general and thus to achieve the organization's goals and determine the level of profitability (Elgin, 2016). With financial analysis, the process of establishing a relationship between financial statement items for a company's financial performance and future plans is carried out (Ayar, 2020). In addition, financial analysis is an analysis designed to evaluate the status and efficiency of a company's use of its economic potential, to determine the strengths and weaknesses of financial and economic activities, and also to optimize results and prepare, determine, and regulate management decisions (Jalal, 2020). Through financial analysis, a result is obtained that guides company managers in strengthening the company's weaknesses and optimizing its strengths, and investors in making a decision to invest in the business.

Financial ratios, one of the most widely used tools in financial analysis, provide the necessary information for decision makers by revealing the relationships between financial statement items (Avcı, 2017). Financial ratios, known as financial indicators, are compared with similar reference ratios and the performance of the analyzed company is evaluated according to the target that the analyzers want to achieve (Bülüc et al., 2017). Financial ratios are considered to be one of the most important methods available as they help to assess the company's performance and determine its ability to meet its debts now and in the future without affecting its production efficiency and effectiveness. Therefore, financial ratios analysis is relied upon to determine the ability of any company to pay all its debts and fulfill them when due, as well as to know the liquidity position of the company in the current or specific time period (Akyüz, 2019; Karadeniz, 2016).

According to the classification in the literature, it is possible to explain financial ratios in 4 groups (Eker, 2014). The financial ratios considered in the study are classified and given in Table 2.

2.1. Liquidity Ratios

These ratios provide insight into a company's ability to pay off its short-term debts. Since they show the relationship between current assets and current liabilities on the balance sheet, the quality of assets should also be reviewed before concluding on the liquidity position after analyzing these ratios (Calis, 2020; Eker, 2014; Gülcan, 2011).

2.2. Financial Structure Ratios (Debt Ratios)

The ratios calculated in relation to the financial structure enable to discover the extent to which each financing source contributes to assets in general and fixed assets in particular (Hayta, 2019; Senel, 2013). In order to reduce the risk level of the company, it is important to finance current assets with short-term debt and fixed assets with long-term debt and/or equity. On the other hand, knowing the share of foreign liabilities in the total resources of the company is of great importance for the lenders of the company in the first place. Another important aspect of measuring the financial structure is to learn the amount of interest incurred by the company. Since the higher the interest burden, the lower the company's profitability, the amount of interest should be taken into account and constantly checked.

2.3. Activity Ratios

Operating ratios measure the efficiency of the company in managing and making optimum use of its assets. As an indicator of whether both working capital and long-term assets are managed correctly, the operating ratio is also considered an indicator of company performance (Calis, 2020).

Through the inventory management, these ratios show the operational status and financial position of the company. They also help interpret liquidity ratios for investors and analysts. To give an example, a company may have a high current ratio, but if the company cannot collect its receivables quickly, it will have difficulty in fulfilling its debts. In other words, it is a big mistake to show the state of a company's actual performance by liquidity ratios alone. Therefore, it is desirable to use turnover ratios and to have high values of these ratios (Ayar, 2020; Khajeh, 2019; Okur, 2021).

2.4. Profitability Ratios

These ratios are used to assess a company's ability to generate profits from its operations against its expenditures and costs and essentially measure returns (Köten, 2017). When a company's profitability growth is in good condition, it means that the future value of the company is high for investors (Imansyah & Mustafa, 2021).

Table 2. *Financial ratios considered in the study and their calculation methods*

	Financial Ratio	**Calculation Method**
L1	Current Ratio	Current Assets / Short Term Liabilities
L2	Cash Ratio	(Current assets - (Inventories + Receivables)) / Short Term Liabilities
L3	Liquidity Ratio	(Current Assets - Inventories) / Short Term Liabilities
L4	Net Working Capital Ratio	Net Working Capital / Total Assets
L5	Cash Flow from Operating Activities / Total Assets	
L6	Current Assets / Net Sales	
L7	Permanent Capital Dependency Ratio	((Inventories + Trade Receivables) - Trade Payables) / Permanent Capital
F1	Total Assets Turnover	Net Sales/Average Assets
F2	Fixed Assets Turnover	Net Sales/Average Fixed Assets
F3	Current Assets Turnover	Net Sales/Average Current Assets
F4	Receivables Turnover	Net Sales/Average Trade Receivables
F5	Inventory Turnover	Cost of Sales/Average Inventories
F6	Net Working Capital Turnover	Net Sales/Average Net Working Capital
F7	Shareholders' Equity Turnover	Net Sales/Average Shareholders' Equity
F8	Permanent Capital Turnover	Net Sales/Average Permanent Capital
F9	Current Assets / Fixed Assets	
K1	Return on Equity	Net Profit / Equity
K2	Return on Sales	Earnings Before Interest and Taxes / Net Sales
K3	Return on Assets	Net Profit / Total Assets
K4	Return on Permanent Capital	/ Perpetual Capital
K5	Gross Profit Margin	Gross Profit / Net Sales
K6	Net Profit Margin	Net Profit / Net Sales
K7	Operating Profit Margin	Operating Profit / Net Sales
K8	Economic Rationality	Earnings Before Interest and Taxes / Total Assets
K9	Cost of Sales / Net Sales	
B1	Equity Ratio	Equity / Total Assets
B2	Leverage Ratio	Total Debt / Total Assets
B3	Debt to Equity Ratio	Total Debt / Equity
B4	Financing Ratio	Equity / Total Debt
B5	Interest Coverage Ratio	Operating Profit / Interest Expense
B6	Fixed Assets / Shareholders' Equity	
B7	Fixed Assets / Permanent Capital	
B8	Short Term Liabilities / Total Assets	
B9	Short Term Liabilities / Shareholders' Equity	
B10	Long-term Liabilities / Total Assets	
B11	Long-term Liabilities / Permanent Capital	
L1-L7 Liquidity Ratios, F1-F9 Operating Ratios, K1-K9 Profitability Ratios, B1-B11 Debt Ratios		

Source: Researcher's compilation based on previous studies.

3. RESEARCH PROBLEM AND APPLICATION

There are many financial ratios that serve to measure the financial efficiency of a company and provide important information for company managers and investors. There are multivariate statistical analysis techniques that can be applied to answer various research questions using these ratio values. The ability to calculate a large number of financial ratios poses various difficulties when it comes to statistical analysis techniques due to the overlapping of variables among themselves and the emergence of correlations that may adversely affect the results of the analysis. In addition, the values of financial ratios do not follow the normality assumption, which is an assumption in most of the multivariate statistical analysis techniques.

In the light of the information provided, the purpose of this study is to reveal the factors representing the financial ratios with the help of principal axis factor analysis by considering the financial ratios for companies traded in Borsa Istanbul (BIST) in Turkey and operating in the manufacturing sector.

3.1. Factor analysis

Factor analysis is one of the important statistical methods that can be used to analyze multivariate data, examine the relationships between variables, and reduce the relationships between these variables or the phenomenon of interest to a smaller number of factors that can explain the phenomenon (Yamaci, 2019). Based on this definition, factor analysis has two main purposes. The first is to reduce the number of variables, and the second is to analyze the relationship between these variables and thus reveal new structures (Kir, 2010).

In order to apply factor analysis and obtain reliable results, some assumptions of this method should be taken into consideration. One of these assumptions is that the data to be used are subject to normal distribution. However, in some cases, the data do not fit the normal distribution. In such cases, principal axis factor method or unweighted least squares method can be used among factor derivation techniques (Fabrigar et al., 1999; Tabachnick & Fidell, 2014).

3.2. Data

The data set used in the study; The number of companies operating in the manufacturing sector in Turkey in 2021 and traded on BIST was determined as 209 (https://www.kap.org.tr/tr/Sektorler). Excluding 23 companies whose 2021 financial statements were not available or could not be reached, 36 financial ratio data were obtained from all other companies.

It was determined that the variables considered as financial ratios did not fit the normal distribution and outliers for each variable were examined in order to make the data more regular and balanced and thus to perform factor analysis. In order to reduce the skewness and to make the variable values more balanced and closer to the normal distribution, the five highest and five lowest values were extracted for each variable. Therefore, the number of observations decreased from 186 to 104. Since the variables did not follow a normal distribution, the principal axis factor method, one of the factor extraction techniques, was applied.

The financial ratios for 104 companies are given in Table 2 and these ratios were prepared to obtain factors using the principal axis factor method.

3.3. Findings

The correlation between 36 variables for the data set considered in the study was analyzed by calculating Spearman's rank correlation coefficient since the variables did not follow a normal distribution. Variables with a correlation value below 0.30 with other variables were excluded from the study since they could not be grouped under a single factor. Variables with a correlation value greater than 0.80 were excluded from the analysis as they could lead to misleading results (Alpar, 2013; Yaslioglu, 2017; Soysal, 2023). Thus, L3, L4, F3, F8, F9, K3, K7, K8, K9, B3, B7, B8, B9 and B11

were excluded from the analysis. There are 22 financial ratios whose correlation structure is suitable for factor analysis.

The Kayser-Meyer-Olkin (KMO) measure measures the adequacy of the data in the study population for factor analysis and takes a value 0 to 1. As the KMO value approaches 1, the more reliable the results of the factor analysis will be. In any case, this measurement value should not be less than 0.60 in order to conduct factor analysis (Arslan et al., 2023). Bartlett's test generally measures the suitability of variables for factor analysis, that is, whether the relationship between variables is sufficient and whether the correlation analysis is statistically significant (Güneren, 2003; Yaslioglu, 2017). Bartlett's test's null hypothesis is the variables are uncorrelated. If the null hypothesis is rejected, it can be concluded that the data set is suitable for analysis (Cengiz, 2007).

In the study, the statistical significance level for Bartlett's test was obtained as 0.001 and thus the null hypothesis was rejected and it was revealed that the variables considered were suitable for factor analysis. The KMO measure was calculated as 0.66, indicating that the sample was sufficient for factor analysis.

In this study, the principal axis factor analysis method was used to derive factors for the financial ratios of a sample of 104 industrial companies listed on BIST. Fabrigar et al. (1999) state that when the distribution of the degrees of the measured variables is moderately normal or close to normal, it is preferable to use the maximum likelihood method without other factor analysis methods. However, if the data distribution is largely non-normal, the principal axis factor method is used.

In order to facilitate the interpretation of the weights of the factors and to ensure the accuracy of the results; the transformed factor matrix was obtained using the Varimax method (Cudeck & MacCallum, 2007).

Table 3. *Eigenvalues and Variance Explained Values of Factors*

Factor	Eigenvalue	Variance (%)	Cumulative Variance (%)
1	4.760	20.697	20.697
2	4.090	17.784	38.481
3	2.487	10.814	49.296
4	2.316	10.069	59.365
5	1.811	7.876	**67.241**

Table 3 shows that the five factors derived from the sample data explain 67.24% of the total variability in the data set. Accordingly, these five factors with eigenvalues greater than "1" are considered to be sufficient to explain the variance of the manufacturing companies included in the study.

The factor loadings for the five extracted factors are presented in Table 4, indicating that most of the variables are statistically significant and have a reasonable saturation for the sample. However, the following points should be taken into consideration:

- If two variables are weighted under more than one factor, this variable should be included in the factor with the highest weight. It does not matter whether the weights are negative or positive (Güneren, 2003).

- The size of the study sample plays an important role in accepting the degree of saturation for a given variable; in this study, the sample was 104 companies and therefore weights of 0.55 and above were considered significant (Alpar, 2013).

Table 4. *Varimax Rotated Factor Matrix*

Variables	Factors				
	1	2	3	4	5
B1	-0.886				
B2	0.879				
B6	0.704				
B4	-0.690				
B10	0.689				
F1		0.955			
F2		0.901			
F7		0.696			
K4			0.617		
K1			0.514		
K2			0.881		
K6			0.688		
L2				0.867	
L1				0.744	
L6					-0.702
L7					-0.673

When Table 4 is analyzed, five financial ratios are included in the first factor: B1 (Equity Ratio), B2 (Leverage Ratio), B6 (Fixed Assets / Equity), B4 (Financing Ratio) and B10 (Long-Term Liabilities (LTL) / Total Assets). Since all ratios in this factor are debt ratios, we decided to call it the debt ratios factor. This factor is of great importance as it explains 20.70% of the variance of the sample.

In the second factor, three financial ratios have significant factor loadings: F1 (Total Assets Turnover), F2 (Fixed Assets Turnover) and F7 (Shareholders' Equity Turnover). The contribution of this factor to the total variance is 17.78%.

The third factor includes four financial ratios: K4 (Return on Perpetual Capital), K1 (Return on Equity), K2 (Return on Sales) and K6 (Net Profit Margin) and since these are all profitability ratios, the third factor can be called the profitability ratios factor. The third factor explains 10.81% of the total variance.

The fourth factor is saturated with two ratios, L2 (Cash Ratio) and L1 (Current Ratio) and since these are liquidity ratios, it is appropriate to call the fourth factor as liquidity ratios factor 1. This factor explains 10.07% of the total variance.

The fifth factor is saturated with two financial ratios, L6 (Current Assets / Net Sales) and L7 (Perpetual Capital Dependency Ratio), and thus, it can be called the liquidity ratios factor 2. Table 3 shows that the fifth factor explains 7.88% of the total variation in the sample.

Financial ratios without factor loadings in Table 4 are excluded from the classification because they have very weak loadings. Thus, the number of ratios grouped under these five factors is 16.

CONCLUSION

In this study, 104 manufacturing companies traded in BIST are taken as a sample and factor analysis is applied to reveal whether the financial ratios exhibiting the financial performance of the companies form a factorization structure.

As a result of the factor analysis obtained with the principal axis factor method, it was concluded that the data structure represented by five factors can represent the actual data instead of a large number of financial ratios in multivariate analyzes that can be applied. The result of grouping the current ratio and cash ratio under a single factor is consistent with the studies of Keskin Benli (2005), Kalaycı and Karatas (2005), Sabau-Popa et al. (2020), Mazhar (2022) and De (2011). However, while the

aforementioned studies group the current ratio and cash ratio together with some other ratios, this study groups only these two ratios under a single factor. This factor alone explains approximately 11% of the total variance. In the study, it is also observed that Current Assets / Net Sales and Perpetual Capital Dependency Ratio, which are included in the liquidity ratios group, form a factor together.

On the other hand, the study revealed different results from previous studies in terms of profitability ratios. In the study, the ratios that constitute the profitability ratios factor as Return on Perpetual Capital, Return on Equity, Return on Sales and Net Profit Margin did not have sufficient factor loadings in previous studies.

In this study, operating ratios are grouped under a single factor as Total Assets Turnover, Fixed Assets Turnover and Equity Turnover. Other operating ratios do not have sufficient factor loadings to be included in the factor. When previous studies in the field are examined, there are different groupings for these ratios (Keskin Benli, 2005). This may be thought to be due to the differences between sectors.

In the debt ratios factor, leverage ratio and financing ratio were included in the same factor, similar to previous studies. Again, the Equity Ratio, Fixed Assets / Equity and Long-Term Liabilities / Total Assets in this factor have appropriate factor loadings in this study, although they are not found significant in other studies.

Thus, the study can be recommended to use the factors representing the 16 ratios obtained in this study to be used in multivariate statistical analyses when analyzing the financial position of a manufacturing industry company in the BIST, while conducting a comparative study among different sectors and finding appropriate ratios that explain the variance in these sectors as much as possible will enrich the study. It is also possible to conduct a comparative study with other sectors in Turkey or among manufacturing companies in another country to see whether the factorization structure of financial ratios is similar.

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