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CATEGORIZATION OF COMPANIES LISTED IN THE BIST NATIONAL 100 INDEX BASED ON FINANCIAL STRUCTURE RATIOS: A CLUSTER ANALYSIS WITH CATEGORICAL VARIABLES

BIST ULUSAL 100 ENDEKSİNDE YER ALAN ŞİRKETLERİN MALİ YAPI ORANLARINA GÖRE SINIFLANDIRILMASI: KATEGORİK DEĞİŞKENLERLE KÜMELEME ANALİZİ

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| ARTICLE INFO | ABSTRACT |
|---|---|
| <p>Received 15.01.2024</p> <p>Revized 13.02.2024</p> <p>Accepted 20.03.2024</p> <p>Article Classification: Research Article</p> <p>JEL Codes C30 C38 G10</p> | <p>This study aimed to categorize companies in the Borsa Istanbul National 100 Index based on financial structure ratios using cluster analysis. Two-stage clustering analysis allowed continuous and categorical variables to be analyzed together. Except for nine banks traded in the Borsa Istanbul National 100 index, the data of 91 companies were analyzed. Research findings showed that the BIST 100 index was divided into two meaningful clusters according to their financial structure ratios and two categorical variables. Fifty-five risk-free companies were clustered in the first cluster, and thirty-six risky companies were clustered in the second cluster. Shareholders' equity / total asset (active) ratio, risk, short-term foreign resources / total resources (passive) ratio, current assets / total asset (active) ratio, fixed assets / total foreign resources ratio, and index were found to be essential variables in clustering companies into two clusters, respectively.</p> <p>Keywords: Financial Structure, Financial Structure Ratios, Cluster Analysis, Categorical Variable</p> |

| MAKALE BİLGİSİ | ÖZ |
|--|--|
| <p>Gönderilme Tarihi 15.01.2024</p> <p>Revizyon Tarihi 13.02.2024</p> <p>Kabul Tarihi 20.03.2024</p> <p>Makale Kategorisi Araştırma Makalesi</p> <p>JEL Kodları C30 C38 G10</p> | <p>Bu çalışmada, Borsa İstanbul Ulusal 100 Endeksi'nde yer alan şirketlerin kümeleme analizi kullanılarak finansal yapı oranlarına göre sınıflandırılması amaçlandı. İki aşamalı kümeleme analizi, sürekli ve kategorik değişkenlerin birlikte analiz edilmesine olanak sağlamıştır. Borsa İstanbul Ulusal 100 endeksinde işlem gören dokuz banka dışında 91 şirketin verileri analiz edildi. Araştırma bulguları, BIST 100 endeksinin mali yapı oranlarına ve iki kategorik değişkene göre iki anlamlı kümeye ayrıldığını gösterdi. Birinci kümede elli beş risksiz şirket, ikinci kümede ise otuz altı riskli şirket kümelendi. Öz sermaye/toplam aktif (aktif) oranı, risk, kısa vadeli yabancı kaynaklar/toplam kaynaklar (pasif) oranı, dönen varlıklar/toplam aktif (aktif) oranı, duran varlıklar/toplam yabancı kaynaklar oranı ve endeks şirketleri sırasıyla iki kümede kümelenmesinde önemli değişkenler olduğu görülmüştür.</p> <p>Anahtar Kelimeler: Finansal Yapı, Finansal Yapı Oranları, Kümeleme Analizi, Kategorik Değişken</p> |

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Introduction

Scientific research on the financial performance indicators of companies traded on the stock exchange is research with important outputs that attract the attention of many segments of society. Particularly in studies on this subject, ratios related to financial performance indicators, collected under four main headings: liquidity ratios, activity ratios (or turnover rates), profitability ratios, and financial structure ratios are used. These ratios are calculated using data from publicly disclosed tables containing the financial information of the companies. Many ratios are calculated under these four headings. Liquidity ratios include the current ratio, acid-test ratio, cash ratio, stocks/active assets ratio, stock dependency ratio, and the ratio of short-term foreign resources (liabilities) to total active assets. Activity ratios (or turnover rates) include inventory turnover rate, receivables turnover rate, working capital turnover rate, net working capital turnover rate, tangible assets turnover rate, liability turnover rate, and asset turnover rate. Profitability ratios include two separate ratios: (i) Ratios that show the relationships between profits and capital and ratios such as earnings (loss) before interest and taxes divided by total liabilities ratio, net profit divided by total active assets ratio, and cumulative profitability ratio and (ii) ratios that show the relationships between profits and sales such as activity profit divided with net sales ratio and gross sales profit divided with net sales ratio. The financial structure ratios consist of a total of eight ratios: (i) the leverage ratio, which is the current assets divided by the short-term foreign resources (liabilities); (ii) the ratio is the shareholders' equity divided by the total asset (active) ratio, (iii) the ratio that is the total equity / total foreign resources (liabilities) ratio, (iv) the ratio that is short term foreign resources (liabilities) divided with the total resource (passive) ratio, (v) the ratio that is the long term foreign resources (liabilities) divided with the total resource (passive) ratio, (vi) the ratio that is the fixed assets divided with the total foreign resources (liabilities) ratio, (vii) the ratio that is the fixed assets divided with the equity ratio and, (viii) the ratio that is the current assets divided with the total asset (active) ratio.

The literature review shows many studies on the financial performance indicators of companies traded on the Borsa Istanbul (BIST), one of the stock exchanges traded worldwide. As seen in the second section of the literature review, the mentioned studies generally investigate companies' performances using various methods or the relationships between several indicator variables. Unlike these conventional studies, this study aims to categorize companies in the BIST National 100 Index based on financial structure ratios using cluster analysis. In addition to the general trend, although clustering studies have been carried out in the literature, these studies are few. This study contributes to the relevant literature and uses categorical variables.

Clustering means finding groups in data (Henning and Meila, 2016: 2). The general purpose of cluster analysis is to classify data according to their similarities (Tatlıdil, 2002: 329). Clustering methods are divided into two basic groups: hierarchical and non-hierarchical methods (Özdamar, 2004: 293). While in a hierarchical method, the clustering process occurs within a hierarchy, whose subsets are aggregated to form higher-level clusters, in non-hierarchical methods, clusters are formed by adjusting the memberships of existing clusters at any stage of the process by moving individuals in or out (Bartholomew et al., 2008: 19-20). Hierarchical classifications are represented by a two-dimensional diagram known as a dendrogram (Everitt et al., 2011: 72). Besides the two well-known

clustering methods, the two-step cluster analysis also exists. In this study, the two-step cluster analysis was performed, and the peculiarity of the method is that it discovers the clusters automatically as opposed to usual methods like Ward's and the k-means methods. It can be applied to large data sets and qualitative and quantitative variables (Alpar, 2011: 339). In this analysis method, if continuous variables are to be analyzed, the Euclidean distance is chosen; if both categorical and continuous, the log-likelihood distance is selected in a two-step cluster analysis (Tkaczynski, 2017: 110). This method assigns the data to small clusters and then applies hierarchical clustering.

The research questions in this study are: (i) Depending on their financial structure ratios, are the companies in the National 100 index divided into clusters? (ii) If so, how many meaningful clusters is it divided into? (iii) which companies are in the clusters? And (iv) what are the essential variables dividing these companies into clusters? Based on the research questions, the rest of the study is organized as follows: In the second part, cluster analysis is briefly explained theoretically. The third section includes the research design and findings. The last section consists of the conclusion.

1. Literature Review

The literature review shows that studies on the financial indicators of companies traded in BIST are mainly carried out around three focal points. These are (i) evaluating the financial performance of companies and analyzing their effectiveness, (ii) investigating the relationships of companies' financial performance indicators with some other variables, and (iii) clustering or classifying companies according to their financial performance indicators.

In the studies on the financial indicators of companies traded in BIST, the interest is in evaluating the financial performance of companies and analyzing their effectiveness using multi-criteria decision-making methods. For instance, the Technique for Order Preference by Similarity (TOPSIS), Data Envelopment Analysis (DEA), Grey Relational Analysis (GRA), Entropy Analysis, Copras method, and so on. Some recent examples of these studies are as follows: Sehil and Tepeli (2024) evaluated the effectiveness of BIST technology companies with data envelopment analysis. Arslan (2024) evaluated the financial performance of BIST weaving and clothing companies using the Copras method. Şenol (2023) evaluated the financial performance of BIST healthcare companies using the TOPSIS method. Çolak (2023) evaluated the financial performance of BIST real estate investment trust companies using the gray relational analysis method. Bektaş (2023) evaluated the financial performance of BIST insurance companies using MABAC, MEREC, and CoCoSo methods. Yılmaz and Yakut (2023) evaluated the financial activities of BIST food, beverage, and tobacco companies using data envelopment and fuzzy data envelopment analysis methods. Çalış and Sakarya (2022) evaluated the financial performance of BIST automotive companies with the CoCoSo method. Kondak (2021) evaluated the financial performance of BIST food companies with the TOPSIS method. Karcioğlu, Yalçın, and Gültekin (2020) evaluated the financial performances of BIST energy companies with intuitive fuzzy logic and entropy-based multi-criteria decision-making methods.

The studies on the financial indicators of companies traded in BIST are interested in investigating the relationships of companies' financial performance indicators with other variables using regression and correlation analysis. For instance, the most popular one is panel data analysis. Some recent examples of these studies are as follows: Doğan and Kalaycı (2024) investigated the

relationship between the activities of BIST food companies and inflation. Researchers performed the Johansen co-integration test and the Granger causality test. Research findings have shown a co-integration relationship between companies' efficiency scores and producer price index and causality between efficiency and producer price index. Bayındır and Aksoy (2024) investigated the relationship between corporate sustainability performance and financial performance of companies other than BIST financial companies. Researchers conducted panel data analysis. Research findings conclude that sustainability performance reduces firms' circus. Dilmaç, Altinkaynak, and Küçüker (2023) investigated the effects of company-specific risks of BIST manufacturing companies on financial performance. Researchers conducted panel data analysis. Research findings conclude that companies are sensitive to risks. Kayacı (2022) investigated the relationship between the level of internationalization and financial performance using data from 295 BIST companies. The researcher conducted panel data analysis. Research findings have shown that their financial performance decreases as firms' internationalization increases.

The studies on the financial indicators of companies traded in BIST are interested in classifying the companies according to their financial performance indicators using multivariate statistical methods. For instance, the most popular methods are hierarchical, non-hierarchical, and two-stage clustering. Some recent examples of these studies are as follows: Özarı and Can (2023) grouped companies according to their financial indicators using BIST production company data. The researchers used the k-means clustering method. Research findings have shown that manufacturing companies are divided into two clusters. Kocabıyık, Orman, and Kıyak (2023) used financial performance data of BIST-30 companies and grouped them according to their financial indicators in two separate periods: before and during the pandemic. Researchers used the Ward clustering method.

Research findings showed different cluster memberships in two separate periods. Tekin and Temelli (2021) grouped companies according to their financial indicators using financial performance data of 272 BIST companies in different sectors. Researchers used a hierarchical clustering method. The research found the most successful and unsuccessful clusters regarding financial performance indicators. Using the financial performance data of BIST-100 companies, Durak and Çömlekçi (2021) grouped the companies according to their financial indicators before COVID-19 and in the COVID-19 period. Researchers used a hierarchical clustering method. Research findings showed that the same number of clusters were obtained in both periods but pointed out that there were different firms and numbers of firms in the clusters. Esmer and Dayı (2019) grouped the companies according to their financial indicators using the financial performance data of BIST automotive companies. Researchers used a hierarchical clustering method. Research findings have revealed companies with similar and distant performance. Using their financial indicators, Tekin (2018) grouped BIST-100 companies, excluding sports clubs and financial companies. The researcher used hierarchical, non-hierarchical, and two-stage clustering methods. The clusters obtained from the research findings were used in stock selection. Arı et al. (2016) grouped 90 BIST companies using financial performance indicators. The researcher used the two-stage clustering method. Research findings pointed to two resolved clusters.

2. Research Design and Findings

The recent data in Turkish Liras currency for 2023 of companies traded in the national 100 index were taken from the official website of BIST (<https://www.borsaistanbul.com/tr/>) in June 2024. BIST includes indices that classify the top companies, such as National 30, National 50, and National 100. Companies in the National 30 index are also included in the national 50 and 100 indexes. Companies in the National 50 index are also included in the National 100 index. On this date, among the National 100, 1 agriculture, forestry, and fisheries; 14 electricity, gas, and water; 26 financial institutions; 38 manufacturing; 4 technologies; 5 wholesale and retail trade, two construction and public works; 3 mining and quarrying, two professional and technical knowledge activities, two transportation and storage, one hotel and restaurants, two information and communications, a total of 100 companies. It was planned to exclude nine banks, including state and public banks, from the analysis and use the data of the remaining 91 companies. Then, the variables seen in Table 1 were calculated for each stock using the EXCEL program.

Table 1: Financial Structure Ratios and Symbols

| Symbols | Names |
|---------|---|
| X1 | Leverage Ratio= Current Assets / Short Term Foreign Resources (Liabilities) |
| X2 | Shareholders' Equity / Total Asset (Active) Ratio |
| X3 | Total Equity / Total Foreign Resources (Liabilities) Ratio |
| X4 | Short-Term Foreign Resources (Liabilities) / Total Resource (Passive) Ratio |
| X5 | Long-Term Foreign Resources (Liabilities) / Total Resource (Passive) Ratio |
| X6 | Fixed Assets / Total Foreign Resources (Liabilities) Ratio |
| X7 | Fixed Assets / Equity Ratio |
| X8 | Current Assets / Total Asset (Active) Ratio |

The leverage ratio (X1) measures a company's inherent financial risk. A ratio approaching zero means a business has almost no debt relative to its equity. A ratio approaching one means that the company's debt and equity capital are equal. The ratio of a company with a sound financial structure is between 0.1 and 0.5, while that of a company with a risky financial structure is 0.5 and above. In this context, a categorical risk variable was created with two categories: risky and risk-free. Companies with leverage ratios between 0 and 0.49 are risk-free, while those between 0.50 and above 0.50 are coded as risky. Here, the number 1 is assigned to risk-free companies, and the number 2 is assigned to risky companies. Also, a three-category categorical variable called "index" was used to distinguish between national 30, 50, and 100. The categories of the categorical variable are coded by assigning the numbers 1 for the National 30 index, 2 for the National 50 index, and 3 for the National 100 index. The descriptive statistics of the variables other than categorical variables are seen in Table 2.

Table 2: Descriptive Statistics of Financial Structure Ratios

| | X2 | X3 | X4 | X5 | X6 | X7 | X8 |
|----------|-------|--------|-------|-------|--------|-------|-------|
| N | 91 | 91 | 91 | 91 | 91 | 91 | 91 |
| Mean | 0.553 | 2.830 | 0.315 | 0.130 | 2.571 | 1.068 | 0.457 |
| Variance | 0.040 | 40.622 | 0.032 | 0.013 | 36.377 | 0.283 | 0.049 |
| Minimum | 0.170 | 0.206 | 0.000 | 0.005 | 0.059 | 0.085 | 0.035 |
| Maximum | 0.981 | 51.725 | 0.805 | 0.545 | 50.282 | 2.816 | 0.965 |

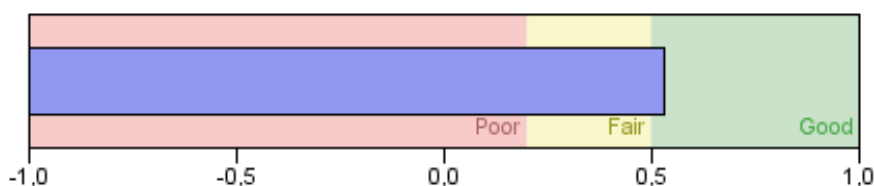
Two-Step Cluster Analysis was performed with SPSS 23 software. In this study, log-likelihood distance was used as a distance measure cause both categorical and continuous variables were included in the analysis. Schwarz’s Bayesian Criterion (BIC) was used as a clustering criterion. The two-step cluster analysis procedures evaluated the importance of cluster quality and predictor (X variables). Figure 1 shows the model summary.

Figure 1: Model Summary: Algorithm, Inputs and Cluster Size

| | |
|------------------|---------|
| Algorithm | TwoStep |
| Inputs | 6 |
| Clusters | 2 |

Depending on the analysis results, a two-cluster solution was obtained with six input data (or variables), which are X2, X4, X6, X8, and two categorical variables (index and risk). This means the companies traded in the national 100 index in 2023 were categorized into two clusters. Figure 2 shows the Silhouette measure of cohesion and separation.

Figure 2: Cluster Quality: Silhouette Measure of Cohesion and Separation



Silhouette measures of cohesion and separation figures show that the cluster quality is fair. This means that the companies are pretty matched to their clusters. Figure 3 shows the importance of the predictors of the variables.

CATEGORIZATION OF COMPANIES LISTED IN THE BIST NATIONAL 100 INDEX BASED ON FINANCIAL STRUCTURE RATIOS: A CLUSTER ANALYSIS WITH CATEGORICAL VARIABLES

The average of the shareholders' equity/total asset (assets) ratio of Cluster 1 is higher than that of Cluster 2. The short-term foreign resources / total resources (passive) ratio of Cluster 1 is lower than that of Cluster 2. The fixed assets / total foreign resources ratio of Cluster 1 is higher than that of Cluster 2. Also, the current assets / total asset (active) ratio of Cluster 1 is lower than that of Cluster 2. Cluster memberships and index numbers (1 for the National 30 index, 2 for the National 50 index, and 3 for the National 100 index) are shown in Table 4.

Table 4: Clusters and Cluster Memberships

| Cluster 1 | | | | Cluster 2 | | | |
|-----------|-------|-------|-------|-----------|-------|-------|-------|
| Name | Index | Name | Index | Name | Index | Name | Index |
| AGROT | 3 | GESAN | 2 | ANSGR | 3 | ULKER | 2 |
| AHGAZ | 3 | GUBRF | 1 | AEFES | 3 | VESBE | 3 |
| AKCNS | 3 | IPEKE | 3 | ARCLK | 2 | VESTL | 2 |
| AKFGY | 3 | ISGYO | 3 | BIMAS | 1 | YYLDG | 3 |
| AKFYE | 3 | IZENR | 3 | BIOEN | 3 | YEOTK | 3 |
| AKSA | 3 | KLSEK | 3 | BRSAN | 1 | ZOREN | 2 |
| AKSEN | 3 | KRDMD | 1 | BFREN | 3 | | |
| ALRK | 1 | KAYSE | 3 | CCOLA | 3 | | |
| ALFAS | 2 | KCAER | 3 | EKGYO | 1 | | |
| ASELS | 1 | KONYA | 3 | ENJSA | 2 | | |
| ASTOR | 1 | KOZAL | 1 | FROTO | 1 | | |
| BTCIM | 3 | KOZAA | 2 | SAHOL | 1 | | |
| BERA | 3 | MIATK | 2 | HEKTS | 1 | | |
| BIENY | 3 | ODAS | 1 | ISMEN | 3 | | |
| BOBET | 3 | OYAKC | 1 | KCHOL | 1 | | |
| BRYAT | 3 | PETKM | 1 | KONTR | 1 | | |
| CANTE | 3 | QUAGR | 3 | MAVI | 3 | | |
| CIMSA | 2 | REEDR | 3 | MGROS | 2 | | |
| CWENE | 2 | SAYAS | 3 | OTKAR | 3 | | |
| DOHOL | 2 | SDTTR | 3 | PGSUS | 1 | | |
| DOAS | 2 | TABGD | 3 | SASA | 1 | | |
| ECZYT | 3 | TUKAS | 3 | SMRTG | 2 | | |
| EGEEN | 2 | TUPRS | 1 | SOKM | 3 | | |
| ECILC | 3 | TTKOM | 2 | TAVHL | 2 | | |
| ENERY | 3 | SISE | 1 | TKFEN | 3 | | |
| ENKAI | 1 | | | TOASO | 1 | | |
| EREGL | 1 | | | THYAO | 1 | | |
| EUREN | 3 | | | TTRAK | 3 | | |
| EUPWR | 2 | | | TCELL | 1 | | |
| GWIND | 3 | | | TURSG | 3 | | |

Cluster 1 is composed of 55 companies, and Cluster 2 is composed of 36 companies. All companies are risk-free in the first cluster, and in the second cluster, all companies are risky.

3. Conclusion

In this study, four research questions were tried to be answered:

- (i) Depending on their financial structure ratios, are the companies in the National 100 index divided into clusters?
- (ii) if so, how many meaningful clusters is it divided into?
- (iii) which companies are in the clusters?
- (iv) What are the essential variables dividing these companies into clusters?

Research findings show that the companies in the BIST 100 index are divided into two meaningful clusters according to their financial structure ratios and two categorical variables. Therefore, the first two research questions were answered as yes and two. Fifty-five companies clustered in the first cluster and 36 in the second cluster. Risk-free companies were clustered in the first cluster, and risky companies in the second cluster. And for the fourth research question, the answer is shareholders' equity / total asset (active) ratio (X2), risk, short-term foreign resources / total resources (passive) ratio (X4), current assets / total asset (active) ratio (X8), fixed assets / total foreign resources ratio (X6) and index respectively. Risk and risk-free companies are clustered correctly. The most influential variable in distinguishing risky and risk-free clusters is the shareholders' equity / total asset (active) ratio, which is in the first order. Investors can consider companies in risky and risk-free groups in their investment preferences.

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