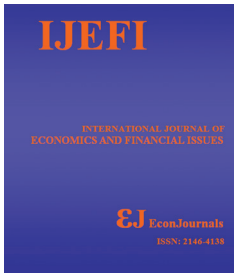

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Portfolio Optimization with Entropy-CRITIC-IDDWS-PROMETHEE Model in BIST Retail Trade Sector

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ABSTRACT

This research aims to construct an ideal stock portfolio by using financial data from firms in the BIST Retail Trade Sector throughout the 2022-2023 timeframe. Entropy, CRITIC, IDDWS and PROMETHEE methodologies were used in the study. The criterion weights were determined using the approaches of Entropy, CRITIC, and IDDWS. The alternatives were ranked using the PROMETHEE method. According to the Entropy method, the most effective evaluation criterion on performance is the return on equity ratio in 2022 and the asset turnover ratio in 2023, according to the CRITIC method, the financing ratio in 2022 and the current ratio in 2023, according to the IDDWS method, the financing ratio in 2022 and the asset turnover ratio in 2023. It was concluded that there were 6 companies with values between 0 and +1 in the entire 2022-2023 period, there were 6 companies on the efficient frontier. These firms are CASA, SOKM, VAKKO, BIMAS, SUWEN and TKNSA. The study has a very unique perspective in terms of both proposing a new and original integrated model (Entropy-CRITIC-IDDWS-PROMETHEE) to investors about optimal portfolio selection and testing the proposed model for the 1st time in this study and the breadth of the data set used.

Keywords: BIST Retail Trade, Portfolio Optimization, Multi Criteria Decision Making
JEL Classification: C61, G11, G17

1. INTRODUCTION

Retail provides intermediary services between the producer and the consumer in order to realize the transportation of goods. From this perspective, it may also be characterized as the whole of the endeavors associated with the promotion and distribution of products and services straight to the final customer, provided that they are kept for commercial purposes and not used for personal needs (Öztürk, 2006, p.69). The retail sector is mainly composed of four sectors; retail trade, non-food (excluding automotive fuel), automotive fuel and food, beverages and tobacco. The non-food sector includes mail or internet shopping, computers, books and communication devices, cosmetics, medical products, clothing and footwear, textiles, electrical goods and furniture. Factors such as the changing demands and The demands of customers, together with the growing range of products and advancements in technology, contribute to heightened competitiveness in the marketplaces. Currently, it is strategically crucial for the retail industry to address evolving client needs. It is essential to answer these requests promptly, in the appropriate location, and in the correct manner (Benli and Özdemir, 2023, p.2).

The continuity and growth of an enterprise is related to its competitiveness. A healthy determination of competitiveness depends on financial performance measurement (Acar, 2003, p.21). While financial performance measurement determines the extent to which resources are used effectively and the level of profitability, information is also obtained on cost control processes and the measurement of company activities (Özçelik and Kandemir, 2015, p.98). In today's highly competitive business landscape,

organizations are compelled to use their financial resources efficiently (Drake and Fabozzi, 2012; Evans and Mathur, 2014). Financial performance measurements provide important insights into the operating cycles of companies. Additionally, it illuminates the ability to forecast the future success of firms by analyzing their historical performance (Evans and Mathur, 2014).

The outputs obtained as a result of financial performance measurement have an impact on decisions such as investment, loan, merger, etc. and are important for senior management making decisions about the business. (Karaoğlan and Şahin, 2018, p.63-64). While the data required for financial performance measurement are mostly obtained from financial statements, measurement is generally made using tools such as vertical analysis, trend analysis, horizontal analysis and ratio analysis (Ceyhan and Demirci, 2017, p.279). On the other hand, since there is no specific criterion that represents performance and since the criteria may vary in terms of number and importance, utilizing numerous criteria for performance assessment is a rational solution. In this direction, recently, multi criteria decision making (MCDM) techniques have gained prominence exceeded 100 in number, are suitable solutions for decision-makers. (Baydaş and Eren, 2021, p.665).

Savers often use both technical and fundamental analysis methods in order to determine the appropriate investment environment and suitable opportunities in order to make decisions on the investments they will make, seeking to optimize their investment returns while minimizing the associated risks (Bayramoğlu and Yayalar, 2017, p.2; Kartal, 2019, p.300). The primary concern for investors is to determine both the most profitable and the most risk-free investment instruments by analyzing many financial securities or assets with distinctive attributes vary throughout various markets within the scope of their objectives. This problem is called portfolio selection problem or portfolio optimization in the finance literature (Grujić, 2015, p.67).

Therefore, the objective of this research is to construct an ideal portfolio of stocks by using the financial data of the firms that are active in the BIST Retail Trade Sector covering the 2022-2023 period within the scope of Entropy, CRITIC, IDDWS and PROMETHEE techniques. The criterion weights were determined using the approaches of Entropy, CRITIC, and IDDWS. The alternatives were ranked using the PROMETHEE method. The study has a very unique perspective in terms of proposing a new and original integrated model (Entropy-CRITIC-IDDWS-PROMETHEE) to investors about optimal portfolio selection, testing the proposed model for the 1st time in this study and the breadth of the data set used.

The contribution of the research to the literature may be summarized as follows: (i) Entropy-CRITIC-IDDWS-PROMETHEE model have been used for the 1st time in the existing body of literature. (ii) The current state of affairs with enterprises in the retail industry with financial performance measurement has been revealed and a comparison between two periods has been presented. (iii) The results obtained on the basis of many weighting techniques have been presented and a comparative analysis has been carried out by revealing the impact of the techniques on the ranking outcomes.

This research consists of five chapters. Immediately after the first segment consisting of the introduction, the second segment summarizes the studies in the literature. The methodology is explained in the third portion, while the application findings are shown in the fourth segment. The last segment, the fifth segment, concludes the study with a general evaluation.

2. LITERATURE REVIEW

Financial performance assessment has been conducted across several areas at BIST. Despite the limited number of research on financial performance assessment in the BIST retail trade sector, the increase in the recent period is noteworthy. This study presents an analysis of financial performance assessment in the retail trade sector of BIST utilizing MCDM approaches.

Uygurtürk and Korkmaz (2016) used total assets, financial leverage ratio, cost of sales, cost of sales, sales revenues and return on assets ratio as input and output in their study for the period 2012-2014 by using data envelopment analysis method. The study concluded that the BIMAS, MGROS, MIPAZ, UYUM, and VAKKO enterprises had excellent levels of efficiency.

Özbek (2016) used net profit margin ratio, return on assets, return on equity, borrowing ratio, financing ratio, equity/total assets, leverage ratio, liquidity ratio and current ratio as evaluation criteria in his study covering the period 2008-2015 by using ELECTRE III COPRAS technique. The research examined the financial performance of the BIMAS, the most successful years were 2009 and 2010, while 2014 was found to be the most unsuccessful year.

Ersoy (2017) studied the period 2010-2014 using TOPSIS, MAUT and SAW methods, including long-term foreign resources/equity ratio, , acid test ratio, current ratio, total foreign resources/total assets ratio, tax./total asset ratio, profit before interest, gross profit margin, receivables turnover rate and asset turnover ratios were used as evaluation criteria. Upon conclusion of the application, it was revealed that the rankings of firm performance varied across all three used methodologies.

Soy Temür et al. (2017) used the TOPSIS approach in their investigation spanning from 2011 to 2016. Leverage ratio, cash ratio, liquidity ratio, current ratio, equity/total liabilities, equity/total assets, short term foreign resource/total liabilities, net sales/equity, net sales/total assets, non-current assets/equity, net profit margin, return on assets, return on equity were taken as evaluation criteria. According to the averages of the period analyzed, BIMAS and KIPA were the highest and lowest performing companies, respectively.

Deste and Halifeoğlu (2019) used the TOPSIS approach in their study covering the 2017-2018 period. Cash ratio, liquidity ratio, current ratio, borrowing ratio, equity ratio, debt/equity ratio, financing ratio, inventory turnover rate, inventory consumption period, operating profit margin, net profit margin and gross profit margin were considered as evaluation criteria. Regarding the financial performance, MGROS, BIMAS and BIZIM were ranked in the first three places.

Pramono et al. (2020) used gross profit margin, current ratio and return on investment ratios in their study on the retail sector in the Indonesian Stock Exchange for the period 2016M1-2017M9 using the paired sample T-test method. An analysis is conducted on the financial performance of 9 retail firms in Indonesia that are listed on the Stock Exchange, comparing their performance before and after the rise of e-commerce over the years 2016-2017. The findings indicate that there is no statistically significant disparity in the gross profit margin, current ratio and return on investment between the periods before and after the advent of e-commerce.

Nguyen et al. (2020) used the SD-based GIA approach in their study on the retail sector in the Vietnam Stock Exchange for the period 2019M1-2020M3. Eighteen financial ratios, including leverage ratios, efficiency ratios, liquidity ratios, valuation ratios, profitability ratios and growth rates were used. The findings indicate that leverage ratios have the most substantial influence on the financial performance of retail enterprises. In addition, AST, MWG, and CIA were found to be three of the most efficient companies.

Şenkal and Öztel (2020) used Entropy-based COPRAS methods in their study covering the 2014-2018 period. Leverage ratio, cash ratio, liquidity ratio, current ratio, short-term liabilities/total passive, long-term foreign resources/total passive, active turnover rate, equity turnover rate, net working capital turnover rate, active profitability rate, return on equity ratio and net profit margin were included in the study as evaluation criteria. In the study in which the financial performance of CRFSA market chain was measured, the years 2015 and 2017 were determined as the most successful and unsuccessful years, respectively.

Sarıay and Bağcı (2020) used net profit, total assets, sales, market capitalization parameters in their study covering the 2014-2018 period using WSA and panel regression methods. CRFSA has the most robust financial performance, whilst MIPAZ and TKNSA have the worst financial performance. Furthermore, it was shown that the financial performance of companies improved in tandem with an increase in asset consumption.

İtik and Sel (2021) used CILOS-based TOPSIS approach in their study covering the period 2013-2019. Return on assets ratio, return on equity ratio, equity turnover ratio, asset turnover ratio, fixed asset/equity, financing ratio, leverage ratio, cash ratio and acid test ratio were considered as evaluation criteria. According to the average performance ranking according to the years, MIPAZ, CASA and VAKKO companies took the first three places.

Yıldırım and Meydan (2021) used intuitionistic fuzzy EDAS and intuitionistic fuzzy Entropy methods for the period 2017-2019. In the study, return on assets, return on equity, fixed assets/continuing capital, debt/equity, total debt ratio, inventory turnover ratio, receivables turnover ratio, asset turnover ratio, liquidity ratio and current ratio were taken into consideration as evaluation criteria. In the period analysed, analyzed, BIMAS was the company with the best performance, while SOKM, CRFSA and MGROS ranked last.

Coşansu and Okursoy (2022) used FUCOM-based VIKOR methods in their study on the 2019-2021 period. Inventory turnover ratio, leverage ratio, current ratio/total assets, current ratio, cost of goods sold/net sales ratios and net profit margin ratio are the evaluation criteria. In terms of financial performance, BIMAS was identified as the top-performing company in 2019, followed by ŞOK and BIMAS in 2020, and SOKM in 2021.

Karapolat and Ceyhan (2022) used the COPRAS method in their study covering the 2014-2019 period. Equity/assets, leverage ratio, current ratio, financing ratio, short term foreign resource/total liabilities, fixed assets/continuing capital, return on assets ratios, return on equity, equity turnover ratio, asset turnover ratio are the evaluation criteria. ADESE had the highest average performance in the relevant period. The only company that did not rank first in this period was BIZIM.

Ergül and Kondak (2022) used the VIKOR method in their study on the 2017-2021 period. Inventory/total assets ratio, cash ratio, current ratio, inventory dependency ratio, borrowing ratio, return on sales ratio, working capital turnover ratio, inventory turnover ratio, receivables turnover ratio, fixed assets/total assets ratio, return on assets ratio, current assets/total assets ratio, asset turnover ratio are the evaluation criteria. In terms of financial performance, BIZIM ranked first in 2017-2019, while BIMAS ranked first in 2020 and VAKKO ranked first in 2021. MIPAZ ranked last in 2017-2018 and 2021, and MEPET ranked last in 2019-2020.

Pala (2022) used MSM and WSM methods in his study covering the period 2018-2021. Debt ratio, current asset turnover ratio, asset turnover ratio, return on equity ratio, net profit margin ratio, net working capital ratio and current ratio were taken into consideration as evaluation criteria. The firm's financial performance rankings fluctuated throughout the years. Considering the average of the period, CASA ranked first. This company was followed by BIMAS, VAKKO and MEPET, respectively.

İç et al. (2022) used AHP, VIKOR, TOPSIS and MOORA methods together with nine financial ratios including profitability ratios, financial structure ratios and liquidity ratios as evaluation criteria in their study. The research found that the VIKOR integrated model, when updated with AHP, had a versatile structure. The AHP-modified VIKOR technique is suggested as a method for evaluating a company's financial performance in comparison to its rivals and devising new strategies for future endeavors.

Eyceyurt Batır (2022) used SWARA-based TOPSIS methods in their study on the 2019-2021 period. Asset turnover ratio, annual growth rate in sales, leverage ratio, current ratio, earnings per share, return on assets and return on sales were taken into consideration as evaluation criteria. In 2019, BIMAS and MGROS ranked in the first two places, while MGROS and BIMAS ranked in the first two places in 2020 and 2021

Budak and Sakarya (2022) used improved Entropy-based TOPSIS methods in their study for the period 2017-2020. Operating cash flow ratio, critical needs ratio, cash ratio, cash-to-current assets ratio, reinvestment ratio, cash-to-average trade receivables, cash-

to-average trade receivables, cash-to-debt ratio, external financing index ratio, recurring capital ratio, cash-to-invested capital ratio, cash-to-assets ratio, cash-to-sales ratio, cash-to-equity ratio, and profit quality are included in the study as evaluation criteria. In the period under review, the most successful companies were MGROS, SOKM, MGROS, MGROS, respectively, while the unsuccessful companies were CRFSA, CRFSA, SOKM, CRFSA, respectively.

Gül and Erdem (2022) used Entropy-based TOPSIS methods in their study covering the period 2013-2020. Inventories/total assets ratio, inventories/current assets ratio, acid-test ratio, current ratio, net working capital turnover ratio, inventory turnover ratio, asset turnover ratio, receivables turnover ratio, gross profit ratio, fixed assets/equity, long-term liabilities ratio, short-term liabilities ratio, liabilities/equity ratio, equity ratio, leverage ratio, tangible fixed asset turnover ratio, operating profit ratio, asset, return on equity ratio and net profit ratio evaluation criteria. BIMAS was identified as the most successful firm throughout the analyzed period.

Ersoy (2023) used LOPCOW-based RSMVC methods in his study covering the period 2017-2021. Current ratio, acid test ratio, leverage ratio, asset turnover ratio, return on assets, return on equity, return on equity and financing ratio were included in the study as evaluation criteria. According to the results obtained, the financial performance of the enterprises shown fluctuations throughout the years. Considering the average rank values of the five periods, it was determined that BIMAS, SOKM and TKNSA took the first three places.

Benli and Özdemir (2023) used the TOPSIS method and used the parameters of profitability, liquidity, financial structure and turnover ratios in their study covering the period 2018-2022. In the period examined, BIMAS, KIMMR, BIMAS, KIMMR and MGROS showed the best performance, respectively. In addition, it was shown that the pandemic did not have a negative impact on every firm, particularly in the non-food industries which gained prominence.

Gül and Yılmaz (2023) used the linear regression estimator method in their study covering the period 2018-2022. Current ratio, operating profitability, financial leverage ratio, return on sales, return on assets, return on equity, working capital turnover ratio, financial expense ratio, market capitalization/book value and long-term debt ratio parameters were included in the study. Based on the findings, VAKKO emerged as the top-performing firm in 2018, while MIPAZ claimed this position from 2019 to 2022. Conversely, CRFSA was identified as the least successful company throughout the period spanning from 2018 to 2022.

Oğuz and Satır (2024) used the net profit margin, operating profit margin, gross profit margin, return on equity ratio, and return on assets ratio parameters for the period 2021-2022 using the MEREC-based COBRA method. Based on the study's findings, MIPAZ achieved the highest level of profitability performance in both years.

3. METHODS

This section provides detailed descriptions and precise mathematical notations of the methodologies used in the research.

3.1. Z Score Standardization Method

To facilitate the comparison of criteria with varying dimensions and units throughout the assessment process, it is necessary to standardize the parts of the decision matrix. Conversely, it is uncommon to come across a negative value in the decision matrix while dealing with MCDM challenges. When negative values are not allowed in the normalized matrix, it is necessary to transform the components of the decision matrix into positive values. The research utilizes the Z-score standardization approach introduced by Zhang et al. (2014) to transform the negative values in the decision matrix into positive ones. The Z-score standardization approach involves the following steps (Zhang et al., 2014, p.3; Ersoy, 2022, p.1451):

Step 1: Equation (1) is used to convert the components of the decision matrix.

$$x_{ij} = \frac{X_{ij} - \bar{X}_0}{S_i} \tag{1}$$

x_{ij} is the standardized data for index i in the j. region, X_{ij} is the raw data, $\bar{X}_i$ and S_i are the arithmetic mean and standard deviation values, respectively.

Step 2: Equation (2) is used to convert the elements of the choice matrix into positive values.

$$x_{ij}^{'} = x_{ij} + A \qquad A > \left| min x_{ij} \right| \tag{2}$$

$x_{ij}^{'}$ is the transformed value's standard value. $x_{ij}^{'} > 0$.

3.2. Entropy Method

Entropy, first described by Clausius (1865), is a quantitative measure of the level of uncertainty and disorder present in a system. It is a technique used to determine objective weights using the information included in the decision matrix (Zhang et al., 2011, p.444). The stages of the Entropy technique are as follows (Wang and Lee, 2009, p.8982):

Step 1: The decision matrix consisting of alternatives (m) and criteria (n) is constructed using equation (3).

$$X_{ij} = \begin{bmatrix} x_{11} & x_{12} & \dots & x_{1n} \\ x_{21} & x_{22} & \dots & x_{2n} \\ \dots & \dots & \dots & \dots \\ x_{m1} & x_{m2} & \dots & x_{mn} \end{bmatrix} \tag{3}$$

Step 2: Equation (4) is used to normalize the decision matrix.

$$P_{ij} = \frac{x_{ij}}{\sum_{i=}^{m} x_{ij}} \tag{4}$$

P_{ij} stands for normalised values.

Step 3: Entropy measure of each criterion is computed using equation (5).

$$e_j = -k \sum_{i=1}^{n} P_{ij} ln P_{ij} \forall_j \tag{5}$$

In Equation (5), k is a constant and is represented by the formula $k = \frac{1}{\ln(m)}$. E_j is the Entropy value of criterion j. m is the number of alternatives.

Step 4: The level of differentiation of the criterion is determined using equation (6).

$$d_j = 1 - e_j, \forall_j \quad (6)$$

d_j denotes a contrast density present in structure j.

Step 5: The calculation of criteria weights is determined by equation (7).

$$W_j = \frac{d_j}{\sum_{k=1}^{n} d_k} \quad (7)$$

$0 \leq w_j \leq 1$ ve $\sum_{j=1}^{n} 1$.

3.3. CRITIC Method

The CRITIC method is based on the standard deviation proposed by Diakoulaki et al. (1995). This approach, the correlation between the criteria as well as the standard deviation of the criteria is taken into account when determining the criteria weights (Wang and Luo, 2010, p.8). The CRITIC approach is a strategy that enhances objectivity in the analytical process by removing the subjective assessments of decision makers. Below is the algorithm for the technique (Diakoulaki et al., 1995, p.764-765; Jahan et al., 2012, p.413; Ersoy, 2022, p.1453):

Step 1: The decision matrix values are normalized using equations (8) and (9).

$$r_{ij} = \frac{x_{ij} - x_j^{min}}{x_j^{max} - x_j^{min}}, i = 1,\ldots,m \quad j = 1,\ldots,n \text{ utility-oriented criteria} \quad (8)$$

$$r_{ij} = \frac{x_j^{max} - x_{ij}}{x_j^{max} - x_j^{min}} i = 1,\ldots,m \quad j = 1,\ldots,n \text{ cost-side criteria} \quad (9)$$

x_j^{max} the best performance of criterion j., x_j^{min} : Denotes the most inferior performance of a criteria j.

Step 2: To quantify the extent of correlation between the assessment criteria, linear correlation coefficients (ρ_{jk}) are calculated using equation (10).

$$\rho_{jk} = \frac{\sum_{i=1}^{m}\left(r_{ij} - \bar{r}_j\right)\left(r_{ik} - \bar{r}_k\right)}{\sqrt{\sum_{i=1}^{m}\left(r_{ij} - \bar{r}_j\right)^2 \sum_{i=1}^{m}\left(r_{ij} - \bar{r}_k\right)^2}} j,k = 1,\ldots,n \quad (10)$$

Step 3: The total information in the criterion (C_j) is determined by using equation (11) whereas the standard deviation (σ_j) is computed using equation (12).

$$C_j = \sigma_j \sum_{k=1}^{n}\left(1 - \rho_{jk}\right) \quad (11)$$

$$\sigma_j = \sqrt{\frac{\sum_{i=1}^{m}\left(r_{ij} - \bar{r}_j\right)^2}{m}} \quad (12)$$

Step 4: The weights of the assessment criteria are determined using equation (13).

$$w_j = \frac{c_j}{\sum_{j=1}^{n} c_j} \quad (13)$$

3.4. IDDWS Method

The introduction of IDDWS by Torkayesh et al. (2021) aimed to ascertain the criterion weights. This approach involves the integration of Entropy and CRITIC approaches, and the ultimate weights are determined via the use of IDDWS, based on the outcomes produced from both methods. Equation (14) is used for weighting the criteria.

$$w_j = \delta * \xi + (1 - \delta) * \zeta$$

The weight coefficients w_j (j = 1, 2., n) indicate the final values. ξ_j represents the weight coefficient acquired using the Shannon Entropy technique, whereas ζ_j represents the weight coefficient gained using the CRITIC method. The symbol δ, which belongs to the interval [0, 1], denotes the coefficient that determines the proportion of the criterion weights in the final choice.

It is advised to use the equality $\delta = 0.5$ for the first ranking of the alternatives. This value ensures that both techniques contribute equally (50% each) to determining the final weights of the criterion. The Shannon Entropy approach favors values $0.5 < \delta \leq 1$, whereas the CRITIC methodology favors values $0 \leq \delta < 0.5$ (Torkayesh et al., 2021, p.6).

3.5. PROMETHEE Method

The PROMETHEE technique is a multi-criteria priority setting strategy that was created by Jean-Pierre Brans in 1982, is a technique developed based on the application phase of the prioritization methods in the literature and applied in many studies today (Brans et al., 1986).

The sequential steps of the method's application are as follows (Brans and Vincke, 1985, p.653; Amaral and Costa, 2014, p.2-3; Maity and Chakraborty, 2015, p.1540-1541; Sen et al., 2015, p.473-474; Apan and Öztel, 2020, p.62; Kaya and Karaşan, 2020, p.96-102; Akbulut and Şenol, 2021, p.167-169; Singh et al., 2021, p.164-165; Süzülmüş and Polat, 2022, p.57-60; Süzülmüş and Yakut, 2024, p.227-228):

Step 1: The decision matrix denoted by $A = [a_{ij}]_{mxn}$ is formed with the alternatives denoted by (X_1,X_2,…, X_m,) in the rows and the criteria to be used in decision making denoted by (Y_1, Y_2,…, Y_n) in the columns.

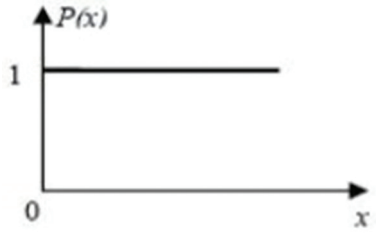
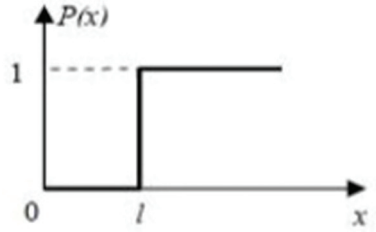
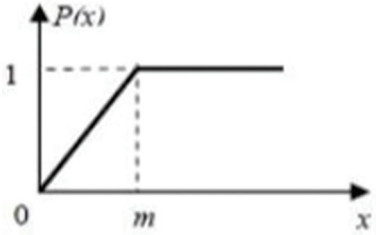
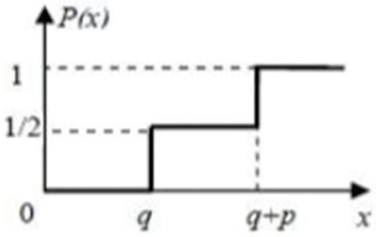
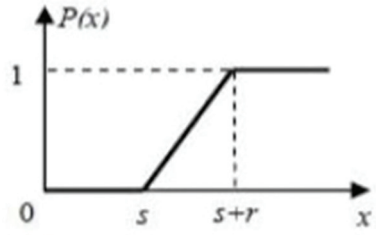
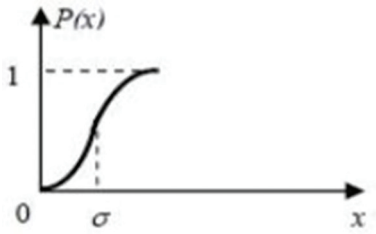
Step 2: The optimal level of preference between alternatives is obtained by using the preference functions shown in Table 1 for the criteria.

Step 3: According to the preference functions, the joint preference functions of alternative pairs are determined. If B_i *ve* $B_{i'}$ represents two alternatives, the joint preference function is found by the equation (15).

$$P_j\left(B_i, B_{i'}\right)=\begin{cases}0 & , f\left(B_i\right)\le f\left(B_{i'}\right)\\ p\left[\left(B_i\right)-f\left(B_{i'}\right)\right], & f\left(B_i\right)>f\left(B_{i'}\right)\end{cases} \quad (15)$$

Step 4: Preference indices are determined by means of equations (16) and (17) for each pair of alternatives compared in joint preference functions.

Table 1: Preference functions

Type	Parameter	Function	Graphic P (x)
Type one (Ordinary)	-	$p(x)=\begin{cases}0, \forall x\le 0\\ 1, \forall x>0\end{cases}$	
Second type (U-type)	*l*	$p(x)=\begin{cases}0, x\le 1\\ 1, x>1\end{cases}$	
Third type (V-type)	*m*	$p(x)=\begin{cases}x/m, x\le m\\ x, x\ge m\end{cases}$	
Fourth type (leveled)	*q, p*	$p(x)=\begin{cases}0, & x\le q\\ \frac{1}{2}, & q<x\le q+p\\ 1, & q>q+p\end{cases}$	
Fifth type (linear)	*s, r*	$p(x)=\begin{cases}0, & x\le s\\ \frac{x-s}{r}, & s\le x\le s+r\\ 1, & x\ge s+r\end{cases}$	
Type six (gaussian)	σ	$p(x)=\begin{cases}0, & x\le 0\\ 1-e^{\frac{-x^2}{2\sigma^2}}, & x\ge 0\end{cases}$	

Source: (Brans and Vincke, 1985, p. 650-652; Dinçer et al., 2017, p. 109; Süzülmüş and Polat, 2022, p. 56; Süzülmüş and Yakut, 2024, p. 227)

$$\pi(B_i, B_{i'}) = [\sum_{j=1}^{n} P_j(B_i, B_{i'}).w_j] \quad (16)$$

$$\pi(B_{i'}, B_i) = [\sum_{j=1}^{n} P_j(B_{i'}, B_i).w_j] \quad (17)$$

Step 5: The calculation of the positive and negative superiority values of pairs of alternatives is determined by equations (18) and (19), respectively.

$$\varphi^{+}(B_i) = \frac{1}{m-1}\sum_{i=1}^{m} \pi(B_i, B_{i'})(i \neq i') \quad (18)$$

$$\varphi^{-}(B_i) = \frac{1}{m-1}\sum_{i=1}^{m} \pi(B_{i'}, B_i)(i \neq i') \quad (19)$$

Step 6: With the PROMETHEE II method, full priority values are calculated for the alternatives using Equation (20), and the full ranking is obtained by ranking the values found from largest to smallest.

$$\varphi(B_i) = \varphi^{+}(B_i) - \varphi^{-}(B_i) \quad (20)$$

4. FINDINGS

The study data comprises the financial information of 15 firms operating in the Borsa Istanbul Retail Trade sector throughout the period of 2022-2023. In the study where seven criteria are used, the criteria are assessed using the Entropy, CRITIC and IDDWS techniques. The PROMETHEE method is used to analyze the yearly financial performance of enterprises in the retail trade sector. During the last phase, a portfolio is constructed using the stocks of firms that are above the efficient frontier, based on the PROMETHEE approach. Subsequently, the performance of this portfolio is assessed. In the study, Microsoft Excel 2016 software was used for Entropy, CRITIC and IDDWS methods and PROMETHEE technique was implemented using the Visual PROMETHEE program. The 15 companies participating in the study are shown in Table 2.

Table 2: Decision alternatives

No	Code	Company title
1	BIMAS	Bim Birleşik Mağazalar A.Ş.
2	BIZIM	Bizim Toptan Satış Mağazaları A.Ş.
3	CRFSA	Carrefoursa Carrefour Sabancı Ticaret Merkezi A.Ş.
4	CASA	Casa Emtia Petrol Kimyevi ve Türevleri Sanayi Ticaret A.Ş.
5	EBEBK	Ebebek Mağazacılık A.Ş.
6	KIMMR	Ersan Alışveriş Hizmetleri ve Gıda Sanayi Ticaret A.Ş.
7	GMTAS	Gimat Mağazacılık Sanayi ve Ticaret A.Ş.
8	MAVI	Mavi Giyim Sanayi ve Ticaret A.Ş.
9	MEPET	Mepet Metro Petrol ve Tesisleri Sanayi Ticaret A.Ş.
10	MGROS	Migros Ticaret A.Ş.
11	MIPAZ	Milpa Ticari ve Sınai Ürünler Pazarlama Sanayi ve Ticaret A.Ş.
12	SUWEN	Suwen Tekstil Sanayi Pazarlama A.Ş.
13	SOKM	Şok Marketler Ticaret A.Ş.
14	TKNSA	Teknosa İç ve Diş Ticaret A.Ş.
15	VAKKO	Vakko Tekstil ve Hazır Giyim Sanayi İşletmeleri A.Ş.

The criteria were established after a thorough examination of existing literature and are shown in Table 3. The necessary data for the study were acquired via the Public Disclosure Platform (PDP) (PDP, 2023).

A decision matrix was constructed based on the options and criteria identified in the research and shown in Table 4. In order not to disrupt the integrity of the study, only the analysis steps for 2022 are presented in detail, and the results for 2023 are presented at the end of the study.

As can be seen from Table 4, the decision matrix contains negative data in some years. During the evaluation, a normalization process is performed to make indicators of different dimensions comparable with each other (Zhang et al., 2014, p.2). Normalization is a procedure that eliminates variations in units and converts data to a designated range, such as 0-1, for all criteria (Aytekin, 2021, p.2). Linear normalization transformation cannot be applied for the decision matrix with a negative index value because it leads to negative values in the normalized decision matrix (Zhang et al., 2014, p.2-3). At the same time, there are difficulties in applying techniques such as vector (Milani et al., 2005), logarithmic (Zavadskas and Turskis, 2008), max-min (Asgharpour, 1999) normalization. In order to avoid these problems, the Z-Score standardization method is applied to convert the negative-valued decision matrix into a positive one.

4.1. Application of Z-Score Standardization Method

During the first phase, which consists of a simple two-step process, the decision matrix elements are standardized by Equation 1 and shown in Table 5.

The decision matrix standardized by Equation 2 is converted to positive and shown in Table 6.

4.2. Application of Entropy Method

As a first step to determine the criterion weights with the entropy method, the decision matrix elements are normalized using Equation 4 and shown in Table 7.

Table 3: Assessment criteria

Financial ratio group	Financial ratios	Code	Description	Opt.
Activity rate	Asset turnover ratio	C_1	Net sales/total assets	Max
Financial structure ratio	Financing rate	C_2	Equity/total debt	Min
	Leverage ratio	C_3	Total debt/total assets	Min
Profitability ratio	Return on assets ratio	C_4	Net profit/total assets	Max
	Return on equity ratio	C_5	Net profit/shareholders' equity	Max
Liquidity ratio	Acid test rate	C_6	Current assets-stocks/short term liabilities	Max
	Current ratio	C_7	Current assets/short term liabilities	Max

Table 4: Decision matrix (2022-2023)

Code	C_1	C_2	C_3	C_4	C_5	C_6	C_7
BIMAS							
2022	2.215	0.860	0.538	0.132	0.285	0.470	0.984
2023	2.217	0.890	0.529	0.104	0.221	0.502	1.007
BIZIM							
2022	3.131	0.249	0.801	0.072	0.362	0.487	0.953
2023	3.478	0.270	0.788	0.008	0.038	0.469	0.847
CASA							
2022	2.461	2.190	0.314	0.199	0.290	16.818	16.818
2023	1.684	1.516	0.398	0.453	0.751	0.202	0.202
CRFSA							
2022	1.977	0.292	0.774	0.063	0.280	0.272	0.699
2023	2.293	0.363	0.734	0.062	0.234	0.280	0.737
EBEBK							
2022	1.962	0.293	0.773	0.060	0.263	0.185	1.036
2023	1.814	0.679	0.596	0.048	0.119	0.548	1.431
KIMMR							
2022	1.664	0.769	0.565	-0.130	-0.298	0.708	1.319
2023	1.649	0.883	0.531	0.095	0.202	0.759	1.229
GMTAS							
2022	0.739	5.179	0.162	-0.002	-0.003	1.012	4.124
2023	1.000	5.944	0.144	0.002	0.002	1.022	3.393
MAVI							
2022	1.387	0.556	0.643	0.127	0.356	0.824	1.270
2023	1.892	0.922	0.520	0.126	0.263	1.067	1.656
MEPET							
2022	1.919	1.977	0.336	0.013	0.019	0.198	0.295
2023	1.851	4.056	0.198	0.108	0.135	0.383	0.565
MGROS							
2022	1.721	0.508	0.663	0.112	0.333	0.352	0.785
2023	1.972	0.649	0.606	0.097	0.246	0.355	0.844
MIPAZ							
2022	0.006	15.545	0.060	0.512	0.545	17.084	17.084
2023	0.000	44.404	0.022	-0.191	-0.195	48.265	48.265
SUWEN							
2022	1.308	1.049	0.488	0.167	0.326	0.611	1.662
2023	1.709	1.304	0.434	0.131	0.231	0.741	1.949
SOKM							
2022	2.402	0.617	0.618	0.149	0.390	0.191	0.883
2023	2.506	0.686	0.593	0.084	0.206	0.290	1.046
TKNSA							
2022	2.979	0.202	0.832	0.048	0.284	0.418	1.078
2023	3.221	0.212	0.825	0.051	0.291	0.352	1.076
VAKKO							
2022	1.058	1.122	0.471	0.224	0.424	0.727	1.870
2023	1.119	1.457	0.407	0.221	0.372	0.618	2.161

Entropy measures and degrees of differentiation were calculated using Equations 5 and 6. The criterion weights were computed in the final stage using Equation 7, and the results are shown in Table 8.

4.3. Determination of Criteria Weights by CRITIC Method

In the first stage, cost-side criteria (financing ratio, leverage ratio) were normalized using Equation 9 and benefit-side criteria were normalized using Equation 8 and shown in Table 9.

The linear correlation coefficients were computed using Equation 10 and shown in Table 10.

The overall information in the criteria was computed using Equation 11, whereas the standard deviation was computed using Equation 12. The weight of each criteria in the final stage was determined by using Equation 13. The resulting weights are shown in Table 11.

4.4. Determination of Criteria Weights by IDDWS Method

The criterion weights were determined using the IDDWS approach, using the data acquired from the Entropy and CRITIC methods. The criterion weights were derived using Equation 14 and are shown in Table 12.

Table 13 shows the results of the criteria weights calculated for all years (2022-2023) examined within the scope of the analysis.

Considering the wj values in Table 13, according to the Entropy method, the most effective evaluation criterion on the performance of the sector companies included in the study is C5 (return on equity ratio) in 2022 and C1 (asset turnover ratio) in 2023; according to the CRITIC method, C2 (financing ratio) in 2022 and C7 (current ratio) in 2023; according to the IDDWS method, C2 (financing ratio) in 2022 and C1 (asset turnover rate) in 2023. On the other hand, the criteria with the least impact on the performance of the firms are according to the Entropy method K2 (financing ratio) in 2022, while K6 and K7 (current ratio and acid test ratio) in 2023;

Table 5: 2021 standardized decision matrix

Code	C_1	C_2	C_3	C_4	C_5	C_6	C_7
BIMAS	0.526	−0.325	0.008	0.112	0.139	−0.397	−0.447
BIZIM	1.675	−0.486	1.170	−0.325	0.528	−0.394	−0.453
CASA	0.834	0.025	−0.983	0.611	0.168	2.523	2.493
CRFSA	0.228	−0.474	1.051	−0.391	0.114	−0.432	−0.500
EBEBK	0.209	−0.474	1.049	−0.418	0.029	−0.447	−0.437
KIMMR	−0.165	−0.349	0.131	−1.810	−2.788	−0.354	−0.385
GMTAS	−1.325	0.812	−1.653	−0.873	−1.304	−0.300	0.136
MAVI	−0.511	−0.405	0.472	0.079	0.495	−0.333	−0.394
MEPET	0.155	−0.031	−0.884	−0.762	−1.193	−0.445	−0.575
MGROS	−0.093	−0.417	0.562	−0.031	0.381	−0.418	−0.484
MIPAZ	−2.244	3.542	−2.101	2.911	1.446	2.571	2.543
SUWEN	−0.612	−0.275	−0.211	0.372	0.346	−0.371	−0.321
SOKM	0.761	−0.389	0.365	0.237	0.666	−0.446	−0.466
TKNSA	1.485	−0.498	1.310	−0.506	0.135	−0.406	−0.430
VAKKO	−0.924	−0.256	−0.285	0.792	0.838	−0.351	−0.282

The value of A in Equation 2 is taken as 2.799

Table 6: Positive decision matrix

Code	C_1	C_2	C_3	C_4	C_5	C_6	C_7
BIMAS	3.325	2.474	2.807	2.911	2.938	2.402	2.352
BIZIM	4.474	2.313	3.969	2.474	3.327	2.405	2.346
CASA	3.633	2.824	1.816	3.410	2.967	5.322	5.292
CRFSA	3.027	2.325	3.850	2.408	2.913	2.367	2.299
EBEBK	3.008	2.325	3.848	2.381	2.828	2.352	2.362
KIMMR	2.634	2.450	2.930	0.989	0.011	2.445	2.414
GMTAS	1.474	3.611	1.146	1.926	1.495	2.499	2.935
MAVI	2.288	2.394	3.271	2.878	3.294	2.466	2.405
MEPET	2.954	2.768	1.915	2.037	1.606	2.354	2.224
MGROS	2.706	2.382	3.361	2.768	3.180	2.381	2.315
MIPAZ	0.555	6.341	0.698	5.710	4.245	5.370	5.342
SUWEN	2.187	2.524	2.588	3.171	3.145	2.428	2.478
SOKM	3.560	2.410	3.164	3.036	3.465	2.353	2.333
TKNSA	4.284	2.301	4.109	2.293	2.934	2.393	2.369
VAKKO	1.875	2.543	2.514	3.591	3.637	2.448	2.517

Table 7: Normalized decision matrix

Code	C_1	C_2	C_3	C_4	C_5	C_6	C_7
BIMAS	0.079	0.059	0.067	0.069	0.070	0.057	0.056
BIZIM	0.107	0.055	0.095	0.059	0.079	0.057	0.056
CASA	0.087	0.067	0.043	0.081	0.071	0.127	0.126
CRFSA	0.072	0.055	0.092	0.057	0.069	0.056	0.055
EBEBK	0.072	0.055	0.092	0.057	0.067	0.056	0.056
KIMMR	0.063	0.058	0.070	0.024	0.000	0.058	0.058
GMTAS	0.035	0.086	0.027	0.046	0.036	0.060	0.070
MAVI	0.054	0.057	0.078	0.069	0.078	0.059	0.057
MEPET	0.070	0.066	0.046	0.049	0.038	0.056	0.053
MGROS	0.064	0.057	0.080	0.066	0.076	0.057	0.055
MIPAZ	0.013	0.151	0.017	0.136	0.101	0.128	0.127
SUWEN	0.052	0.060	0.062	0.076	0.075	0.058	0.059
SOKM	0.085	0.057	0.075	0.072	0.083	0.056	0.056
TKNSA	0.102	0.055	0.098	0.055	0.070	0.057	0.056
VAKKO	0.045	0.061	0.060	0.086	0.087	0.058	0.060

Table 8: *ej*, *dj* and *wj* values

Values	C_1	C_2	C_3	C_4	C_5	C_6	C_7
e_j	0.973	0.982	0.973	0.978	0.964	0.981	0.980
d_j	0.027	0.018	0.027	0.022	0.036	0.019	0.020
w_j	0.159	0.108	0.160	0.132	0.210	0.114	0.116

Table 9: Normalized decision matrix

Code	C_1	C_2	C_3	C_4	C_5	C_6	C_7
BIMAS	0.707	0.957	0.382	0.407	0.691	0.017	0.041
BIZIM	1.000	0.997	0.041	0.315	0.783	0.018	0.039
CASA	0.785	0.870	0.672	0.513	0.698	0.984	0.984
CRFSA	0.631	0.994	0.076	0.301	0.685	0.005	0.024
EBEBK	0.626	0.994	0.077	0.295	0.665	0.000	0.044
KIMMR	0.531	0.963	0.346	0.000	0.000	0.031	0.061
GMTAS	0.235	0.676	0.869	0.198	0.350	0.049	0.228
MAVI	0.442	0.977	0.246	0.400	0.776	0.038	0.058
MEPET	0.612	0.884	0.643	0.222	0.377	0.001	0.000
MGROS	0.549	0.980	0.219	0.377	0.748	0.010	0.029
MIPAZ	0.000	0.000	1.000	1.000	1.000	1.000	1.000
SUWEN	0.417	0.945	0.446	0.462	0.740	0.025	0.081
SOKM	0.767	0.973	0.277	0.434	0.816	0.000	0.035
TKNSA	0.951	1.000	0.000	0.276	0.690	0.014	0.047
VAKKO	0.337	0.940	0.468	0.551	0.856	0.032	0.094

according to the CRITIC method, K5 (return on equity ratio) in 2022, K4 and K5 (return on equity and return on assets ratio) in 2023; according to the IDDWS method, it was determined that K6 (acid test ratio) in 2022 and K5 (return on equity ratio) in 2023.

Table 10: Linear correlation coefficients

Criterion	C_1	C_2	C_3	C_4	C_5	C_6	C_7
C_1	1.000	0.702	−0.712	−0.461	−0.045	−0.301	−0.355
C_2	0.702	1.000	−0.766	−0.708	−0.247	−0.712	−0.737
C_3	−0.712	−0.766	1.000	0.462	−0.065	0.622	0.675
C_4	−0.461	−0.708	0.462	1.000	0.807	0.692	0.678
C_5	−0.045	−0.247	−0.065	0.807	1.000	0.308	0.281
C_6	−0.301	−0.712	0.622	0.692	0.308	1.000	0.992
C_7	−0.355	−0.737	0.675	0.678	0.281	0.992	1.000

Table 11: *Cj*, *σj* ve *wj* values

Values	C_1	C_2	C_3	C_4	C_5	C_6	C_7
C_j	4.222	5.887	3.748	2.785	2.137	2.668	2.790
σ_j	0.589	0.695	0.648	0.615	0.431	0.607	0.625
w_j	0.174	0.243	0.155	0.115	0.088	0.110	0.115

Table 12: Criteria weights

Weight	C_1	C_2	C_3	C_4	C_5	C_6	C_7
w_j	0.167	0.176	0.158	0.123	0.149	0.112	0.115

Table 13: Calculated *wj* values for the criteria

Method	C_1	C_2	C_3	C_4	C_5	C_6	C_7
Entropy							
2022	0.159	0.108	0.160	0.132	0.210	0.114	0.116
2023	0.183	0.108	0.179	0.162	0.155	0.107	0.107
CRITIC							
2022	0.174	0.243	0.155	0.115	0.088	0.110	0.115
2023	0.142	0.165	0.134	0.107	0.107	0.171	0.173
IDDWS							
2022	0.167	0.176	0.158	0.123	0.149	0.112	0.115
2023	0.163	0.136	0.156	0.135	0.131	0.139	0.140

4.5. Application of PROMETHEE Method

The results obtained from Entropy, CRITIC and IDDWS methods in the first stage of the analysis were analyzed in the second stage based on PROMETHEE I and PROMETHEE II methods within the Visual PROMETHEE Academic package program. However, here again, due to the fact that the study covers more than one period, only the IDDWS-weighted PROMETHEE findings for the year 2022 are reported. At the end of the study, aggregated results are presented in tables.

In the first stage of the method, an initial decision matrix is created as in all other MCDM methods. The decision matrix is given in Table 6. Then, in the second stage of the method, the preference functions that are most appropriate for the evaluation criteria examined within the scope of the analysis are determined. While determining the preference functions, Type Three (Type V) functions, which are mostly used in the analysis of quantitative criteria depending on both the structure of financial ratios and the standard deviations in the series, were preferred.

Based on the preference functions calculated in the third stage of the method, preference indices are determined for each pair of decision alternatives in the fourth stage. By utilizing these indices, the positive and negative values of the firms in the range of +1 and −1 are determined in the fifth stage of the method. The positive values expressed here express the positive superiority value of the decision alternatives included in the scope of the analysis compared to the other alternatives, while the negative values express the weakness of the decision alternatives compared to the other alternatives.

Table 14 shows the positive and negative superiority values of the sector firms included in the scope of the analysis calculated for the year 2022. When these results are taken into consideration, it can be said that the performance of firms with large positive superiority values is higher, whereas the performance of firms with small positive superiority values is lower.

In the sixth stage of the method, the PROMETHEE I partial ranking results calculated using the positive and negative superiority values reported in Table 14 are shown in Figure 1. The left column in Figure 1 represents positive superiority values while the right column represents negative superiority values. Here, it can be stated that the top ranked firms in both columns are more dominant than other firms.

In the last stage of the method, full ranking results are determined by PROMETHEE II. The full superiority values determined show which stocks should be included in the portfolio. Accordingly, the companies between 0 and +1 should be included in the portfolio.

Figure 2 shows that 9 companies (CASA, MIPAZ, SOKM, BIZIM, BIMAS, TKNSA, VAKKO, SUWEN, MGROS) have values above 0 and 6 companies have values below 0. Therefore, it can be stated that there are 9 firms that should be included in a portfolio to be formed. Table 15 shows the positive and negative superiority values calculated by Entropy, CRITIC and IDDWS criteria weighting methods for all periods included in the study.

Considering the results in Table 15, it is concluded that there are

Table 14: 2022 positive and negative superiority values

No	Code	Phi	Phi+	Phi-
1	CASA	0.234	0.268	0.034
2	MIPAZ	0.139	0.356	0.217
3	SOKM	0.057	0.114	0.058
4	BIZIM	0.039	0.116	0.077
5	VAKKO	0.038	0.129	0.091
6	BIMAS	0.034	0.097	0.063
7	SUWEN	0.017	0.098	0.080
8	TKNSA	0.010	0.100	0.090
9	MGROS	0.001	0.079	0.078
10	MAVI	−0.001	0.082	0.084
11	CRFSA	−0.024	0.069	0.093
12	EBEBK	−0.027	0.068	0.095
13	MEPET	−0.089	0.072	0.161
14	GMTAS	−0.167	0.084	0.251
15	KIMMR	−0.262	0.038	0.300

6 firms that are in the range of 0 and +1, in other words, on the efficient frontier in all periods covered by the study and covering the 2022-2023 time interval. As mentioned above, these firms are CASA, SOKM, VAKKO, BIMAS, SUWEN and TKNSA. In addition, the returns obtained from the shares of these firms and 9 other firms were compared with the returns obtained by the BIST Trade (XTCRT) sector and the BIST-100 (XU100) index in the same period. The values related to the returns are shown in Table 16.

Considering the data in Table 16, it is seen that the firm return is higher than the sector index and the BIST-100 index in two of the six firms (SUWEN, VAKKO), which were identified based on the selected decision alternatives and evaluation criteria. The return of three firms (BIMAS, SOKM, TKNSA) is higher than the BIST-100 index and lower than the sector index. The return of one firm (CASA) is lower than the sector index and the BIST-100 index. In addition, the returns of three of the other 9 companies (MAVI, MGROS, MIPAZ) included in the scope of the analysis for the period 2022-2023 are higher than both the index returns and the BIST-100 returns. The returns of the remaining six companies (BIZIM, CRFSA, EBEBK, KIMMER, GMTAS, MEPET) are lower than both the index returns and the BIST-100 returns. According to these results, in general, it can

Figure 1: PROMETHEE I partial ranking results for 2022

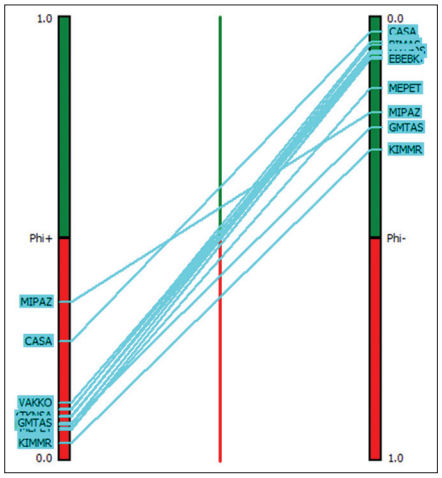


Figure 2: PROMETHEE II full ranking results for 2022

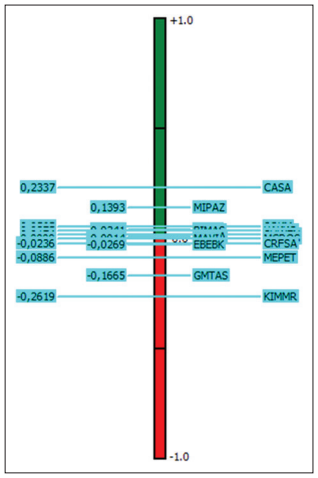


Table 15: Positive and negative superiority values for the period 2022-2023

No	2022						2023					
	Entropy		CRITIC		IDDWS		Entropy		CRITIC		IDDWS	
	Code	Phi	Code	Phi	Code	Phi	Code	Phi	Code	Phi	Code	Phi
1	CASA	0.245	CASA	0.223	CASA	0.234	CASA	0.196	CASA	0.118	CASA	0.157
2	MIPAZ	0.199	MIPAZ	0.082	MIPAZ	0.139	TKNSA	0.051	TKNSA	0.031	TKNSA	0.041
3	SOKM	0.064	SOKM	0.049	SOKM	0.057	MEPET	0.034	MAVI	0.014	MAVI	0.024
4	VAKKO	0.055	BIZIM	0.038	BIZIM	0.039	MAVI	0.033	BIMAS	0.013	BIMAS	0.023
5	BIZIM	0.040	BIMAS	0.031	VAKKO	0.038	BIMAS	0.032	SOKM	0.013	SOKM	0.022
6	BIMAS	0.037	VAKKO	0.021	BIMAS	0.034	SOKM	0.030	SUWEN	0.009	MEPET	0.021
7	SUWEN	0.026	TKNSA	0.014	SUWEN	0.017	SUWEN	0.027	MEPET	0.008	SUWEN	0.018
8	TKNSA	0.006	SUWEN	0.009	TKNSA	0.010	VAKKO	0.026	VAKKO	0.003	VAKKO	0.014
9	MAVI	0.006	MGROS	−0.004	MGROS	0.001	MGROS	0.012	MGROS	−0.003	MGROS	0.004
10	MGROS	0.005	MAVI	−0.009	MAVI	−0.001	CRFSA	0.004	CRFSA	−0.007	CRFSA	−0.002
11	CRFSA	−0.025	CRFSA	−0.022	CRFSA	−0.024	KIMMR	−0.008	KIMMR	−0.017	KIMMR	−0.012
12	EBEBK	−0.030	EBEBK	−0.024	EBEBK	−0.027	BIZIM	−0.019	BIZIM	−0.017	BIZIM	−0.018
13	MEPET	−0.112	MEPET	−0.066	MEPET	−0.089	EBEBK	−0.041	MIPAZ	−0.029	EBEBK	−0.039
14	GMTAS	−0.183	GMTAS	−0.151	GMTAS	−0.167	GMTAS	−0.119	EBEBK	−0.038	GMTAS	−0.109
15	KIMMR	−0.333	KIMMR	−0.192	KIMMR	−0.262	MIPAZ	−0.257	GMTAS	−0.097	MIPAZ	−0.144

Table 16: Return comparisons

Code	Company returns %	XTCTR returns %	XU100 returns %
BIMAS	411.567	414.674	299.208
BIZIM	203.184	414.674	299.208
CASA	−23.185	414.674	299.208
CRFSA	167.73	414.674	299.208
EBEBK	42.326	414.674	299.208
KIMMR	96.764	414.674	299.208
GMTAS	263.959	414.674	299.208
MAVI	638.911	414.674	299.208
MEPET	229.004	414.674	299.208
MGROS	795.847	414.674	299.208
MIPAZ	1,076.364	414.674	299.208
SUWEN	449.893	414.674	299.208
SOKM	315.639	414.674	299.208
TKNSA	364.789	414.674	299.208
VAKKO	806.363	414.674	299.208

be stated that the criteria determined by the integrated models preferred in the analysis process have produced a partially successful result.

5. CONCLUSION

Portfolio selection is a crucial concern in finance at the present day that financial investors or decision makers are intensely interested in and can be expressed as the selection of an optimum portfolio in line with predefined constraints and predefined objectives. Portfolios are comprised of several equities that may be influenced by economic crises or shocks, political upheavals, financial swings, and quickly advancing technologies. In the process of making investment decisions, savers may face great pressure because of their restricted financial resources. Incorrect or imprecise investment choices may lead to failure in achieving the expected returns, negatively impacting both companies and investors.

The inclusion of various variables in the investment choice process will increase its complexity. Hence, to ensure accurate investment judgments, it is essential to use logical decision-making procedures and prioritize analytical methodologies. One of these methods is MCDM approaches. These approaches offer optimal solutions to savers in the investment decision process. The PROMETHEE technique is MCDM approach, is one of the methods that offer analytical solutions to savers in this sense. PROMETHEE approach is very efficient and straightforward that offer the most effective and easiest solution suggestions in multi-problem decision processes. Multiple decision criteria are determined and weight coefficients are assigned to these criteria according to their importance level and a ranking can be easily made among decision alternatives.

In this study, an integrated model for the portfolio selection problem is proposed using the financial data of the companies in Retail Trade sector operating in BIST covering the period 2022-2023. Firstly, the important weights of the assessment criteria included in the study are determined using the Entropy, CRITIC, and IDDWS methodologies. The criterion with the highest importance weight is the return on equity ratio in 2022 and the asset turnover ratio in 2023 based on the Entropy technique, the financing ratio in 2022 and the current ratio in 2023 according to the CRITIC method, and the financing ratio in 2022 and the asset turnover ratio in 2023 according to the IDDWS method. In the period in question, the most important criteria affecting firm performance are current ratio, asset turnover rate, return on equity and financing ratio. This result is an indication of how important profitability, equity, sales and liquidity are for firms to carry out their activities and increase firm performance. In addition, it has been concluded that the criterion with the least effect on firm performance in the period in question varies according to the years.

In the second phase, the importance of criteria weights obtained from Entropy, CRITIC and IDDWS methods were included in the PROMETHEE method and it was determined which of these firms had a value above the efficient frontier. According to the findings obtained from the PROMETHEE method, 6 firms were found to be above the efficient frontier in all periods included in the scope of the analysis. These companies are CASA, SOKM, VAKKO, BIMAS, SUWEN and TKNSA. Therefore, it can be stated that these firms can be included in an optimal portfolio to be constructed.

Consequently, within the scope of the selected decision options and evaluation criteria, it can be stated that the integrated model preferred in the analysis process and the criteria determined in the analysis process have produced a partially successful result. The results obtained can be used in portfolio management, portfolio optimization, portfolio investments, investments, investors and companies that want to provide returns to their investors above the efficient frontier.

The asset turnover ratio, financing ratio, leverage ratio, return on assets ratio, return on equity ratio, acid test ratio and current ratio, which were established due to a thorough literature review, constituted the indicators of the study. When assessed based on the acquired results, the results are in line with (Benli and Özdemir, 2023; Budak and Sakarya, 2022; Coşansu and Okursoy, 2022; Deste and Halifeoğlu, 2019; Ersoy, 2023; Eyceyurt Batır, 2022; Ergül and Kondak, 2022; Gül and Erdem, 2022; Gül and Yılmaz, 2023; İtik and Sel, 2021; Pala, 2022; Soy Temür et. al 2017; Uygurtürk and Korkmaz, 2016; Yıldırım and Meydan, 2021), while there is a similarity in the financial performance of firms throughout the years as in the studies, there is a modify in the financial performance of firms throughout the years in the studies of (Şenkal and Öztel, 2020; Sarıay and Bağcı, 2020; Karapolat and Ceyhan, 2022; Oğuz and Satır, 2024).

This study also has some limitations. Firstly, the use of PROMETHEE method based on Entropy, CRITIC and IDDWS method within the scope of the analysis can be considered as a limitation. The use of financial data only for the years 2022-2023 and the inclusion of only one sector in the scope of the analysis can also be stated as a restriction. Therefore, in future investigations, different financial indicators, different samples, a different period or periods, and the use of different MCDM techniques will contribute to the literature.

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