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Ranking State-Run Banks Using Multi-Criteria Decision Making Methods Taking Advantage of the Banking Health Criteria

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Abstract

This study primarily aims to evaluate the performance and ranking of state-run banks using multi-criteria decision making methods. One of the most main performance evaluation methods is the calculation of financial criteria. There are different systems to evaluate the financial performance of banks, and in line with the health of banks these systems utilize banking health criteria. In this study, four principal criteria, namely asset quality, liquidity, capital adequacy, profitability and ten financial sub-criteria have been used in ranking state-run banks. The focal problem in analyzing financial ratios is that each financial measure evaluates a specific aspect of organizations' financial performance; therefore, financial ratios cause confusion for managers and investors. As a result, solutions are needed to overcome these limitations; multi-criteria decision-making methods are among these solutions. This study uses the MEREC method, which is one of the new methods of multi-criteria decision-making, due to such advantages as giving more weight to a criterion whose removal leads to greater effects on the performance of all options, helping decision makers to eliminate some criteria in the decision making process, and not involving the relative valuation, and weighing the options based on experts' opinions. Furthermore, based on the characteristics of multi-criteria decision-making methods, MARICA, CODAS, and EDAS methods were also used to rank state-run banks in the year 2019, and finally, the results of the methods were combined using the Borda and Copeland methods.

***Keywords**:* Ranking, Performance Evaluation, Banking Health Criteria, Multi-Criteria Decision Making Methods

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1. Introduction

In the existing literature on today's world economy, the importance and position of money and financial institutions like banks as a tool for economic growth and development of countries is tangible(Sabokro et al.,2021). Therefore, banks have an important contribution in the field of continuous development and optimal allocation of financial resources. As a result, not only can their performance quality contribute to developing competitiveness in the highly competitive markets of the banking industry, but it is also able to have direct effects on the economic performance of countries (Karataeva & Shikhveledova, 2020). Banks play a significant role in creating credit and transferring resources to the real sector of the economy and the growth and stability of the financial system. A banking system, which enjoys indicators of stability and banking health, can show more resilience in the event of financial crises in the economy, and provide a basis for strengthening the economic system of countries. Nowadays, banks in advanced countries act as facilitators, professional consultants, experts in increasing the financial resources of companies and collecting and exchanging the necessary information for their customers (Zarutska et al., 2020). Banks are also among the economic drivers of every country, causing a tight competitive environment among them. In order to overtake each other in increasing their own market share and profitability, banks are utilizing various methods to improve performance in attracting customers. Among these methods is evaluating the performance of banks which is of particular importance (Aytaç et al., 2021).

Performance evaluation of an organization is an integral part of the management of any organization, which allows determining the impact of management decisions on the performance results, as well as the direction of the results and the decisions that should be made to improve them (Narkunienė & Ulbinaitė, 2018). Performance evaluation is a key factor in improving the quality of work input and motivates employees to be engaged more. Performance evaluation also introduces a basis for promotion and escalation in an organization's development and succession planning. Performance evaluation system is different according to the nature of work and assignment in an organization (Shaout & Yousif, 2014). Performance evaluation is the monitoring, management and improvement of measurable criteria that show how to perform tasks and create motivation in order to achieve the organization's goals (Najmi & Kehoe,2001).

Performance evaluation of the banking sector has turned into a very challenging task (Botshekan et al., 2021); therefore, many factors must be taken into account to distinguish good banks from bad ones. There are various models, including the Six Sigma model, balanced scorecard, and financial performance evaluation, to evaluate the performance of banks.

The Six Sigma model is a lateral quality improvement technique widely adopted in industry. The fundamental objectives of Six Sigma methodology are implementation of strategies based on performance measurement through improvement projects. This is a business improvement approach that seeks to find and eliminate the causes of flaws or defects in business processes by focusing on process outputs that are critical to customers. The term sigma is a measure that indicates the deviation of a service's performance characteristic from its average performance (Nayeri & Rostami, 2016).

The balanced scorecard model was developed by Kaplan and Norton (2001). This model evaluates the performance of both financial and non-financial aspects of a company using criteria of different structures. Since these indicators are correlated with the strategy of an organization, this model can help in strategic planning. The balanced scorecard model focuses on four criteria, namely customer financial metrics, internal process, learning and growth metrics (Chen et al., 2010).

One of the most important performance evaluation models is financial performance evaluation. Financial performance evaluation is a process that helps shareholders to make optimal investment decisions and helps users of financial reports to evaluate the company's financial status and obtain an estimate of the company's value. Financial ratios are the most useful indicators for evaluating the performance and financial status of companies. Financial performance evaluation criteria are preferable to non-financial criteria due to their quantitative, practical, objective, and tangible characteristics.

There are various systems to evaluate the financial performance of banks. The Patrol system was approved by the Central Bank of Italy in 1993 as an external monitoring tool on the health of private banks and includes such financial criteria as capital adequacy, profitability, credit quality, organization, and liquidity. The PEARLS system is a set of financial metrics used to assess and monitor the financial stability of credit unions in the World Council of Credit Unions (WOCCU), which includes supporting financial criteria, effective financial structure, asset quality, rate of return and cost, liquidity, and signs of growth.

The CAMEL system is one of the most famous financial health ratios offered in the banking industry, which was recommended by the National Credit Union Supervisory Authority of the United States of America in 1988 and approved by the Basel Committee. In this model, the key elements of a bank's financial conditions that affect its credit value are examined in five areas: capital adequacy, asset quality, management quality, profitability, and liquidity. Among the banking health assessment methods, CAMEL is a suitable and simple model for financial evaluation and management assessment. In addition, CAMEL rating represents the quality of financial conditions, an image of the state of risks and the overall performance of the bank (Al-abedallat, 2019; Botshekan et al., 2021; Roman & Sargu, 2013; Rostami, 2015).

The components of CAMEL include capital adequacy, asset quality, management efficiency, profitability, and liquidity management. Capital adequacy refers to the adequacy of the amount of capital available to support the bank's business and in case of any adverse situation or shock, it acts as a shock buffer. Asset quality is about the quality of the bank's loan, which is the main asset that generates a major share of the bank's income. Management efficiency deals with the quality of bank management in efficient use of resources, maximizing income, and reducing operating costs. Profitability copes with how to absorb losses and increase capital, and liquidity management refers to the bank's ability to fulfill its obligations, especially to depositors (Desta, 2016). The CAMELS system includes all the components of the CAMEL system, but the Michigan State Board of Financial Institutions used this system for the first time in 1977 by adding an element of market risk sensitivity (S) to the CAMEL system and converted it to CAMELS. But still, most

developing countries use CAMEL instead of CAMELS to evaluate the performance of the financial organization (Bovenzi, 2015).

In the analysis of financial criteria, it is important to note that each of the financial indicators evaluates a specific aspect of the organization's financial performance. In addition, aggregating the analysis of different groups of financial criteria is not an easy task, and it is not possible to comment on their totality. Due to these limitations, the financial criteria of managers and investors are confusing. As a result, researchers are looking for solutions to solve these limitations. Among these solutions are Multi-criteria decision-making methods that can be used to rank and evaluate the performance of banks. Therefore, the efficiency of these methods can be better seen in the comparison and evaluation of banks.

One of the new multi-criteria decision-making methods is the MEREC method, which is used to weight the criteria. Among the outstanding features of this method compared to the other multi-criteria decision-making methods is that this method uses each criterion's removal effect on the performance of options to determine criteria weights. It gives more weight to the criterion whose removal leads to greater effects on the total performance of the options. It also helps decision makers to eliminate some criteria in the decision making process. In addition, the non-involvement of relative valuation and the application of experts' discretion and the difference in the displacement between the formula of benefit and cost criteria and the conversion of criteria into minimization type criteria are the other prominent features of this method (Keshavarz Ghorabaee et al., 2021).

In the present study, the performance of state-run banks is evaluated according to their nature, function and mission, and they are tools for governance and development activities of the government, which cannot be compared with private banks. To do so, the financial performance of five state-run banks in the year 2019 has been examined for the first time with regard to the public disclosure of the financial statements of state-run companies in order to increase public supervision over the performance of state-run companies and improve performance. This has been done through taking benefit from multi-criteria decision-making methods, including MEREC methods to weight the selected criteria and MARICA, CODAS and EDAS methods to rank and compare the results of each method.

Multi-criteria decision models are divided into compensatory models and non- compensatory models, and each model includes several subgroups. Compensatory models are methods in which trade-offs among criteria are allowed, and the decision maker is willing to trade-off between the criteria, and a change in one criterion is compensated by an opposite change in another criterion or criteria. Non-compensatory models are models in which trade-offs among criteria are not allowed. In other words, the weakness in one criterion is not compensated by the advantage in another criterion, and the decision maker is not willing to trade-off between the criteria, and each criterion is the basis for evaluating other options separately from other criteria. The models of the methods selected in this study are of compensatory type due to the permissibility of trade-offs among the criteria. Compensatory models include three subgroups as follows.

(1) Coordinated subgroup: its output is a set of ranks in a way that will provide the necessary coordination in the most appropriate way;
(2) Compromise subgroup: in the methods related to this subgroup, the options that are closest to the ideal solution will be preferred. MARICA, CODAS and EDAS methods are in this subgroup; and
(3) Scoring subgroup: this subgroup tries to estimate a utility function for each option, among which the option with the highest utility will be selected; therefore, the problem in this subgroup is how to estimate the multi-criteria utility function (Jamei, 2020). The MEREC method is in this subgroup.
The methods used in this study are related to compromise and scoring subgroups of the compensatory models. The reason for choosing MARICA, CODAS, and EDAS methods from a compromise subgroup is that each of them performs different ranking methods.

2. Literature Review

So far, several studies have evaluated banks using multi-criteria decision-making methods. Muhammad et al. (2021) evaluated the performance of five Islamic banks in Pakistan using ten financial criteria during the years 2019 to 2021. The researchers assigned weights to each criterion based on the priorities of the criteria. They made use of the TOPSIS method for ranking. In another study, Aydin (2020) evaluated the performance of sixteen foreign deposit banks in Turkey using the criteria of total assets, total loans, off-balance-sheet accounts, number of branches, total number of employees, ratio of personnel expenses to total assets, ratio of net income to total assets, and capital adequacy ratio during the years 2016 to 2019. The researcher used the Standard Deviation method to weigh the criteria and the COPRAS method to rank the options.
In a study regarding the process of liberalization and the possibility of foreign capital entering Serbia, which leads to more competition in banks, Marjanović and Popović (2020) evaluated the performance of twenty-five banks using the financial criteria of return on assets, capital adequacy ratio, loan loss ratio to total loans, loan to deposit ratio, net profit margin and cash and cash equivalent of deposits during the years 2012 to 2017. The researchers used the CRITIC method to weigh the criteria and the TOPSIS method to rank the options. In another study, Sama et al. (2022) evaluated the performance of eighteen private banks using four input criteria of total assets, deposits, facilities and operating expenses and four criteria of net profit output, cash, investment, and advance payments during the year 2018. The researchers used the CRITIC method to weigh the criteria, the GRA and TOPSIS methods to rank the options, and the Wilcoxon signed-rank test to compare the methods. The results indicated that the ranking obtained by GRA and TOPSIS methods was similar.
Ünvan (2020), in another study, evaluated the performance of seven banks in Turkey using five main financial criteria of balance sheet ratios and capital structure, asset ratios, liquidity ratios, profitability ratios, income cost structure ratios, and ten sub-criteria during the years 2014 to 2018. Considering the increase in risk, uncertainty and competition in the banking sector, the researcher

used phased approaches that are more sensitive in evaluations. In this research, a fixed weight of one tenth has been assigned to each of the criteria, and TOPSIS and FTOPSIS methods have been used to rank the options. The results showed that the FTOPSIS method gives very strong results in the environment of uncertainty among multi-criteria decision making methods. In another study, Pekkaya and Demir (2018) prioritized CAMELS dimensions according to bank performance through the AHP method. The results indicated that the dimension of asset quality was the most important dimension of CAMELS while the dimensions of market sensitivity and capital adequacy were identified as weak dimensions of CAMELS.

Roy and Das (2018) in an article evaluated the performance of 19 banks (i.e., state-run, private, and foreign commercial banks) in Bangladesh using four main measures of profitability and efficiency ratios, size and growth criteria, power and accuracy ratios, asset quality ratios, and twenty-five sub-criteria during the years 2000 to 2013. The researchers used Shannon's Entropy for weighing and TOPSIS for ranking. The results indicated that foreign commercial banks and private commercial banks outperformed state-run commercial banks the profitability, efficiency, strength and accuracy, size and growth, and asset quality. Furthermore, Gökalp (2015) evaluated the financial performance of state-run banks, private banks and foreign banks in Turkey using five main capital adequacy ratios, asset quality, management, profitability, liquidity, and twelve sub-criteria in the CAMEL framework during the period before the crisis (2006 to 2008) and after the crisis (2009 to 2012). The researcher used Gaussian preference function for weighing and the PROMETHEE method for ranking. The results indicated that state-run banks were significantly affected by the 2008 financial crisis. The evaluated State-run banks ranked first between 2006 and 2008 but ranked last in the period from 2008 to 2012, when the foreign banks ranked first.

Önder et al. (2013) evaluated the performance of seventeen banks in Turkey using ten main criteria and fifty-seven sub-criteria during the years 2002 to 2011. The researchers used the AHP method to weigh the criteria and the TOPSIS method to rank the options. The results indicated that the ratio of net profits (losses) to total assets, the ratio of equity to total assets are the five important financial ratios for evaluating banks, the ratio of consumer loans to total loans and accounts receivable, the ratio of equity to the amounts of credit risk + market risk + operational risk, the ratio of net profits (losses) to total equity. Finally, Akkoç and Vatansever (2013) evaluated the performance of twelve commercial banks using seventeen financial performance evaluation criteria in 2010. The researchers used FAHP and FTOPSIS methods for ranking. The results showed that these two methods rank banks in a similar way.

Having reviewed the conducted studies in this field, we realized that these studies are different from each other in different ways. The first difference lies in the use of various financial criteria to evaluate the health of the banking industry. Other aspects of differentiation include different methods used in weighting criteria, different methods used in ranking options (the studied banks), and different criteria used in ranking banks.

In the present study, the performance of five state-run banks is evaluated according to the position of the banks and the important role they play in the field of continuous development and optimal allocation of financial and credit resources. Therefore, in order to compare, clarify the performance

and select the best state-run banks, their performance needed to be evaluated. To do so, based on an in-depth review of the existing literature, several criteria that were used in evaluating the performance and ranking of banks in various studies in this domain were examined and discussed. Among these criteria are the four main criteria of asset quality, liquidity, capital adequacy, profitability and ten sub-criteria. The sub-criteria encompass the ratio of doubtful receivables to non-current receivables (A1), the ratio of the volume of general and private reserves to non-current facilities (A2), Ratio of facility balance to total assets (A3), the ratio of low-yielding and non-productive assets to total assets (A4), the NPL[1] ratio (A5), the ratio of facilities to deposits (A6), the ratio of facilities to resources (equipable resources other than deposits) (A7), cash and quasi-cash assets to total deposits (L1), capital adequacy ratio (C1), the ratio of net income of facilities and deposits to the balance of facilities granted (P1) under the framework of Banking health systems were selected according to the number of repetitions (frequency) in the previous studies and based on experts' opinions.

In addition, to weigh state banks, the MEREC method, which is one of the new methods of multi-criteria decision making, was used. This method was preferred over the others because of the weaknesses of other weighting methods, namely the existence of more comparative data and less stable comparisons due to relative valuation and applying more discretion in AHP and ANP methods, not considering the effects of removing each of the criteria on the performance of the total options to calculate the weight of the criteria in the Shannon entropy and CRITIC methods, absence of a mechanism with strong mathematical logic in order to consolidate the opinions of several experts in the BWM method, and so forth. Finally, the ranking results of the MARICA, CODAS and EDAS methods was compared.

3. Method

The MEREC Method

This technique was first presented by Keshavarz Ghorabaee et al. (2021). The MEREC method is a new objective weighting method that uses the effects of removing criteria in the decision matrix to determine their importance. Unlike other methods, MEREC focuses on the deletion perspective and the effects of deletion rather than the addition perspective to determine the weights of objective criteria. To do so, the following steps need to be followed.

Step One: Construct the decision matrix. A decision matrix is formed in this step, which shows the ranking or values of each option with respect to each criterion. The elements of this matrix are denoted by *xij*, and these elements must be greater than zero *(xij > 0)*. If we have negative values in the decision matrix, they Non-Performing Loans should be converted to positive values using the appropriate technique. Suppose there are n options and m criteria. In this case, the form of the decision matrix is as follows:

Equation (1)

$$X = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1j} & \cdots & x_{1m} \\ x_{21} & x_{22} & \cdots & x_{2j} & \cdots & x_{2m} \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\ x_{i1} & x_{i2} & \cdots & x_{ij} & \cdots & x_{im} \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\ x_{n1} & x_{n2} & \cdots & x_{nj} & \cdots & x_{nm} \end{bmatrix}$$

Step Two: Normalize of the initial decision matrix (N). In this step, simple linear normalization is used to scale the elements of the decision matrix. The elements of the normalized matrix are denoted by n_{ij}^{x}. If B represents the set of benefit criteria and H represents the set of cost criteria, we can use the following equation for normalization.

Equation (2)

$$\mathrm{n}_{ij}^{x} = \begin{cases} \frac{\min\limits_{k} x_{kj}}{x_{ij}} \; if \; j \in B \\ \frac{x_{ij}}{\max\limits_{k} x_{kj}} \; if \; j \in H \end{cases}$$

Step Three: Calculate the overall performance of options (S_i). A logarithmic measure with equal weighting of criteria is applied to obtain the overall performance of the options at this stage. Considering the normal values obtained from the previous step, we can make sure that smaller values of n_{ij}^{x} result in larger values of function (S_i).

Equation (3)

$$S_j = ln\left(1 + \left(\frac{1}{m}\sum_j \left|ln\left(n_{ij}^{x}\right)\right|\right)\right)$$

Step Four: Calculate the performance of the options by removing each criterion. In this step, we use the same logarithmic criterion as in the previous step. The difference between this step and the third one lies in the performance of options which is calculated based on the elimination of each criterion separately. Therefore, we have m sets of functions associated with m criteria. The overall performance of option *i* in the case of removing criterion *j* is denoted by S'_{ij}.

Equation (4)

$$S'_{ij} = ln\left(1 + \left(\frac{1}{m}\sum_{k,k\neq j} |ln(n_{ik}^{x})|\right)\right)$$

Step Five: Compute the summation of absolute deviations (E_j). In this step, the effect of removing criterion *j* is calculated based on the values obtained from steps 3 and 4.

Equation (5)

$$E_j = \left|S'_{ij} - S_j\right|$$

Step Six: Determining the final weights of the criteria (Keshavarz Ghorabaee et al., 2021).

Equation (6) $$w_j = \frac{E_j}{\sum_k E_k}$$

The MAIRCA Method

The MAIRCA method is one of the new multi-criteria decision making techniques that is presented to select the most appropriate option. The main assumption of the MAIRCA method is to determine the distance between ideal and experimental weights. Overall gaps for each criterion describe the total gap for each option. Finally, the ranking of the options is discussed.

Step One: Forming the initial decision matrix (X).

Equation (7) $$X = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ x_{m1} & x_{m2} & \ldots & x_{mn} \end{bmatrix}$$

Step Two: Preference determination according to the option selection P_{A_i}. During option selection, the decision maker is neutral to the process. In fact, the decision maker does not prefer any of the proposed options. The basic assumption is that the decision maker does not consider the probabilities of selecting each option.

Equation (8) $$P_{A_i} = \frac{1}{m};\ \sum_{i=1}^{m} P_{A_i} = 1, i = 1, 2, \ldots, m$$

In the above equation, m specifies the total number of options. In decision analysis, we assume that the decision maker is risk neutral with the mentioned probabilities. In this case, all preferences are equal according to the selection of certain options, that is, all P_{A_i} are equal.

Equation (9) $$P_{A_1} = P_{A_2} = \cdots = P_{A_m}$$

Step Three: Calculate theoretical evaluation matrix elements (Tp). The theoretical evaluation matrix (Tp) is created with $n \times m$ format (n is the number of the total criteria, m is the total number of options). The elements of the theoretical evaluation matrix (tpij) are calculated as the coefficient of preference as options P_{A_i} and the weight of criteria (W) as given below.

Equation (10)
$$T_p = \begin{bmatrix} t_{p11} & t_{p12} & \cdots & t_{p1n} \\ t_{p21} & t_{p22} & \cdots & t_{p2n} \\ \cdots & \cdots & \cdots & \cdots \\ t_{pm1} & t_{pm2} & \cdots & t_{pmn} \end{bmatrix} = \begin{bmatrix} P_{A_1}w_1 & P_{A_1}w_2 & \cdots & P_{A_1}w_n \\ P_{A_2}w_1 & P_{A_2}w_2 & \cdots & P_{A_2}w_n \\ \cdots & \cdots & \cdots & \cdots \\ P_{A_m}w_1 & P_{A_m}w_2 & \cdots & P_{A_m}w_n \end{bmatrix}$$

Since the decision maker is unbiased or neutral for the initial selection of options, all preferences (P_{A_i}) for all options are equal, so the above equation can be shown as follows.

Equation (11)
$$T_p = P_{A_i}\begin{bmatrix} t_{p1} & t_{p2} & \cdots & t_{pn} \end{bmatrix} = P_{A_i}\begin{bmatrix} P_{A_i}w_1 & P_{A_i}w_2 & \cdots & P_{A_i}w_n \end{bmatrix}$$

Step Four: Determining the real evaluation equation. The calculation of the elements of the real evaluation matrix (Tr) is done by multiplying the elements of the theoretical evaluation matrix (Tp) and the elements of the initial decision matrix (X) according to the following equations, which is equation 12 for positive criteria and equation 13 for negative criteria.

Equation (12)
$$t_{rij} = t_{pij}\left(\frac{x_{ij}-x_i^-}{x_i^+-x_i^-}\right)$$

Equation (13)
$$t_{rij} = t_{pij}\left(\frac{x_{ij}-x_i^+}{x_i^--x_i^+}\right)$$

$x_i^+ = \max(x_1, x_2, \ldots, x_m)$ and $x_i^- = min(x_1, x_2, \ldots, x_m)$ indicate the highest and lowest values that are observed among the options in a specific criterion.

Step Five: Calculate the total gap matrix (G). The elements of the matrix G are calculated as the difference (distance) between the theoretical evaluations (t_{pij}) and the actual evaluations (t_{rij}), which are expressed according to the following equation.

Equation (14)
$$G = \mathrm{Tp} - \mathrm{Tr} = \begin{bmatrix} g_{11} & g_{12} & \cdots & g_{1n} \\ g_{21} & g_{22} & \cdots & g_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ g_{m1} & g_{m2} & \cdots & g_{mn} \end{bmatrix} = \begin{bmatrix} t_{p11}-t_{r11} & t_{p12}-t_{r12} & \cdots & t_{p1n}-t_{r1n} \\ t_{p21}-t_{r21} & t_{p22}-t_{r22} & \cdots & t_{p2n}-t_{r2n} \\ \cdots & \cdots & \cdots & \cdots \\ t_{pm1}-t_{rm1} & t_{pm2}-t_{rm2} & \cdots & t_{pmn}-t_{rmn} \end{bmatrix}$$

Step Six: Calculate the sum of the final values of the total gap (Q). Based on the following equation, we get the final values for each option, and based on that, the options are ranked. In fact, the lower the final values for an option, the higher the ranking will be (Gigović et al., 2016).

Equation (15)
$$Q_i = \sum_{j=1}^{n} g_{ij}, i = 1, 2, \ldots, m$$

The CODAS Method

The CODAS method is one of the new distance-based multi-criteria decision making methods presented by Keshavarz Ghorabaee et al. (2016). This method determines the desirability of options based on two methods. The first method is calculating the Euclidean distance of the options from the negative ideal and the second method is calculating the Taxicab distance of the options from the negative ideal.

Step One: Forming the initial decision matrix (X).

Equation (16)
$$X = [x_{ij}]_{m\times n} = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ x_{m1} & x_{m2} & \ldots & x_{mn} \end{bmatrix}$$

Step Two: Calculate the normalized decision matrix.

Equation (17)
$$n_{ij} = \begin{cases} \frac{\min_k x_{kj}}{x_{ij}} \; if \; j \in N_b \\ \frac{x_{ij}}{\max_k x_{kj}} \; if \; j \in N_c \end{cases}$$

Where N_b and N_c represent the benefit and cost criteria respectively.

Step Three: Calculate the weighted normalized decision matrix.

Equation (18)
$$r_{ij} = w_j n_{ij}$$

Step Four: Calculate the negative ideal solution.

Equation (19)
$$ns = [ns_j]_{1\times m}$$

Equation (20)
$$ns = \min_i r_{ij}$$

Step Five: Calculate the Euclidean and Taxicab distances of options from the negative-ideal solution.

Equation (21)
$$E_i = \sqrt{\sum_{j=1}^{m}(r_{ij} - ns_j)^2}$$

Equation (22)
$$T_i = \sqrt{\sum_{j=1}^{m}|r_{ij} - ns_j|}$$

Step Six: Forming the relative assessment matrix.

Equation (23) $$Ra = [h_{ik}]_{n\times n}$$

Equation (24) $$h_{ik} = (E_i - E_k) + (\psi(E_i - E_k) \times (T_i - T_k))$$

Where $k \in \{1, 2, \dots, n\}$ and ψ represents a threshold function to detect the equality of Euclidean distances of two options.

Equation (25) $$\psi(x) = \begin{cases} 1 & if \quad |x| \geq \tau \\ 0 & if \quad |x| \leq \tau \end{cases}$$

In this function, τ is a threshold parameter that can be set by the decision maker. It is recommended to set this parameter in a value between 0.01 and 0.05.

Step Seven: Calculate the assessment score of each option.

Equation (26) $$H_i = \sum_{k=1}^{n} h_{ik}$$

Step Eight: Ranking the options according to the decreasing values of the assessment score (H_i). The replacement with the highest H_i is the best option among the options (Keshavarz Ghorabaee et al., 2016).

The EDAS Method

This technique was first presented by Keshavarz Ghorabaee et al. (2015). In the EDAS method, the best solution is related to the distance from the average solution (AV). In this method, positive and negative ideals need not to be calculated, two criteria are considered to evaluate the desirability of options. The first measure is the positive distance from average (PDA) and the second is the negative distance from average (NDA). These measures can show the difference between each option and the average solution.

Step One: Forming the initial decision matrix (X).

Equation (27) $$X = [x_{ij}]_{m\times n} = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ x_{m1} & x_{m2} & \dots & x_{mn} \end{bmatrix}$$

Step Two: Calculate the average solution criteria. In this step, using the following equation, the average solution for the criteria is calculated, which is actually the average of the data for each criterion column.

Equation (28) $$AV = \left[AV_j\right]_{1\times m}$$

Equation (29) $$AV_j = \frac{\sum_{i=1}^{n} X_{ij}}{n}$$

Step Three: Calculate PDA and NDA. In this step, using the following equation, PDA and NDA are calculated. If the criterion is positive, the following equation is used. The positive side means that increasing the criterion will bring profit.

Equation (30) $$PDA_{ij} = \frac{\max\left(0,\left(X_{ij}-AV_j\right)\right)}{AV_j}$$

Equation (31) $$NDA_{ij} = \frac{\max\left(0,\left(Av_j-X_{ij}\right)\right)}{AV_j}$$

If the criterion is negative, the following equation is used. The negative side means that lowering the criterion will cause profit.

Equation (32) $$PDA_{ij} = \frac{\max\left(0,\left(Av_j-X_{ij}\right)\right)}{AV_j}$$

Equation (33) $$NDA_{ij} = \frac{\max\left(0,\left(X_{ij}-AV_j\right)\right)}{AV_j}$$

Step Four: Calculate SP and SN values. This step is the weighting of the PDA and NDA values of the previous step, and the weight of the criteria should be multiplied by these variables.

Equation (34) $$SP_i = \sum_{j=1}^{m} w_j PDA_{ij}$$

Equation (35) $$SN_i = \sum_{j=1}^{m} w_j NDA_{ij}$$

Step Five: Calculate normal values of SP and SN.

Equation (36) $$NSP_i = \frac{SP_i}{max_i(Sp_i)}$$

Equation (37) $$NSN_i = 1 - \frac{SN_i}{max_i(SN_i)}$$

Step Six: Final ranking of options. In this step, using the following equation, the final scoring of the options is calculated, and then they are ranked accordingly.

Equation (38) $$AS_i = \frac{1}{2}(NSP_i + NSN_i)$$

Where $0 \leq AS_i \leq 1$ (Keshavarz Ghorabaee et al., 2015).

The Borda and Copeland Methods

This method works according to the majority principle and compares the ranks of each pair found in other methods. If the number of pairs in which the alternative k is preferred over the alternative L outnumbers the pairs in which the alternative L is preferred over the alternative K, the state is denoted by M. However, if the alternative k outnumbers the alternative L, the situation is indicated by X. In such a situation, Ms represents the number of "wins" and Xs represents the number of losses. An M indicates a win for the alternative in its row over its column. Conversely, an X indicates a win for the alternative in its column over its row. The score given to each option is determined by calculating its number of wins (the number of Ms in its row). Copeland's method can be considered an improved version of Borda's method because M and X values are considered in the prioritization process in this new method. In Copeland's method, the score given to each option is determined by subtracting the number of wins from the losses (Kiani et al., 2022).

4. Results

In the present study, the data related to the selected criteria for the five state-run banks in 2019 have been collected. Considering the availability of consolidated financial statement information for the end of the fiscal year ending on 03/20/2019 and the selected criteria during the specified time period, five banks, namely Maskan (Housing), Melli (National), Keshavarzi (Agriculture), Bank of Industry and Mine, and Export Development Bank of Iran, have been selected based on the systematic elimination method from among the state-run banks operating in Iran. Information about banks is given in Table 1.

Table 1. Financial Criteria of Banks

Main Criterion	Asset Quality							Liquidity	Capital Adequacy	Profitability
Banking Health Indicators	A1	A2	A3	A4	A5	A6	A7	L1	C1	P1
Housing Bank	88.8	45	72.1	13.7	7.6	126.4	80	19.7	11.7	4.3
National Bank	65.6	124	43	20.5	4.7	55.7	47.8	9.6	-11.1	-0.5
Agriculture Bank	70.1	73.5	54.1	14.1	11.4	68.1	62.5	0.4	3.6	6
Bank of Industry and Mine	92.7	61.8	75.3	19.4	7.5	399	93.6	7	2.	3.2
Export Development Bank of Iran	92.7	81.2	56.3	22.6	9.3	137.7	78.9	49.4	12.3	1.7

As it can be seen, the financial ratios of the five state-run banks in 2019 are given. In the ratio of doubtful receivables to non-current receivables, which can be bad debts, all banks are in trouble, which is an alarm for the health of the banking system. In the ratio of the volume of public and private reserves to non-current facilities, except for the Housing Bank, the rest of the banks have good reserves, indicating the stability of the banks. In the ratio of facility balance to total assets, all the five banks had a defensible performance. All banks had problems in the ratio of low-yielding and non-productive assets to total assets. In the NPL ratio, except for the National Bank, the other banks were in trouble. In terms of the ratio of facilities to deposits and the ratio of facilities to resources (equipped resources other than deposits), all the banks, except for National Bank, were good.

With regard to the ratio of facilities to deposits and the ratio of facilities to resources (equipped resources other than deposits), all of the banks, except for the National Bank, had a good performance. As regards cash and quasi-cash assets to total deposits, the only bank which did not have a good performance was the Bank of Agriculture. As regards the capital adequacy ratio, based on the limits of supervision set by the Central Bank, which is eight percent, the three banks of the National Bank, Bank of Agriculture, and Bank of Industry and Mine had problems, and the Housing Bank and Export Development Bank of Iran had a good capital adequacy ratio. In the ratio of the net income of facilities and deposits to the balance of granted facilities, all of the banks, except National Bank, had a good status. Finally, the state-run banks were in a good condition in terms of liquidity, and their status was relatively acceptable concerning asset quality, capital, and liquidity.

Seven of the sub-criteria used in this study were positive, and the more the criteria increase, the better it is for the system (banks). In addition, three sub-criteria (ratio of doubtful receivables to non-current receivables (A1), the ratio of low-yielding and non-productive assets to total assets (A4) and the NPL ratio (A5)) were negative, and the more the criteria decrease, the better it is for the system (banks). The values of the final weights of the criteria using the MEREC method are shown in Table 2. Due to the presence of the negative values in capital adequacy and the ratio of the net income of facilities and deposits to the balance of granted facilities, these values should be converted to positive values using appropriate techniques (Keshavarz Ghorabaee et al., 2021). In the present study, according to the experts' opinions, in the criteria that had negative values, the values of the desired criteria became positive by adding the integer part of the absolute value of the largest negative number plus one to all values.

Table 2. The Final Weights of the Criteria

The	A1	A2	A3	A4	A5	A6	A7	L1	C1	P1
Obtained Weights	0.0157	0.0530	0.0288	0.0244	0.0407	0.0712	0.0358	0.3102	0.2440	0.1761

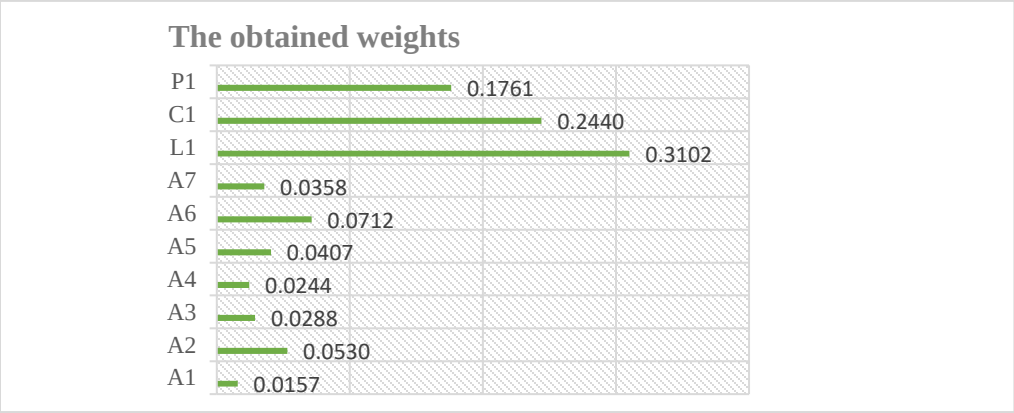

Figure 1. The Optimal Weight of Criteria

The results showed that based on the MEREC method, from among the financial ratios, the three ratios of cash and quasi-cash assets to total deposits, capital adequacy ratio, and the net income of facilities and deposits to the balance of granted facilities had more weight and importance than the other criteria. In the following, the ranking of the banks will be discussed with the multi-criteria decision-making method of MARICA, CODAS and EDAS. Due to the high volume of calculations, only the final ranking results are given in Table 2.

Table 3. Rating of Banks Using Multi-Criteria Decision-Making Methods

Banks	Ranking by MARICA method	Ranking by CODAS method	Ranking by EDAS method
Housing Bank	2	2	2
National Bank	5	5	5
Agriculture Bank	4	3	4
Bank of Industry and Mine	3	4	3
Export Development Bank of Iran	1	1	1

Based on Table 3, the ranking was done by the three methods of MARICA, CODAS and EDAS in 2019. The results indicate that almost the same ranking can be seen for the banks with the existing methods in 2019. Based on the ranking of the banks using the mentioned methods, the Borda and Copeland methods have been used to combine and integrate these three multi-criteria decision-making methods to reach the final ranking. Table 4 shows the final ranking of the state-run banks in 2019 using the Borda and Copeland methods.

Table 4. The Final Ranking of Banks Using the Borda and Copeland Methods

Banks	**Ranking by Borda Method**	**Ranking by Copeland Method**
Housing Bank	2	2
National Bank	5	5
Agriculture Bank	4	4
Bank of Industry and Mine	3	3
Export Development Bank of Iran	1	1

Based on the examined criteria and using the aforementioned methods, the ranking results can be seen in Table 4. The results showed that Export Development Bank of Iran and the Housing Bank ranked first and second respectively due to their banking health criteria. Export Development Bank of Iran had a good status in terms of asset quality and liquidity and an acceptable status in the other ratios. In the same vein, the Housing Bank had a good status in terms of capital and liquidity and an acceptable status in the other ratios.

5. Conclusion, Implications, and Suggestions

Through using multi-criteria decision making methods, the present study aims to evaluate and rank the five state-run banks in Iran in terms of performance indicators, whose criteria and sub-criteria have earlier been introduced. Banks play a significant role in transferring financial resources to industries and their distribution in the economy as well as financial growth and stability. A healthy banking system with proper functioning can successfully overcome financial crises. Performance evaluation of an organization is an integral part of the management of any organization, which

allows for determining the impact of management decisions on performance results as well as the direction of the results and the decisions that should be made to improve the results. Performance evaluation of the banking sector has become a very challenging task; therefore, many factors must be considered to distinguish good banks from bad banks.

Nowadays, banks are faced with a wide range of methods for performance evaluation. One of the most important performance evaluation models is financial performance evaluation. Financial performance evaluation is a process that helps shareholders make optimal investment decisions and helps users of financial reports evaluate the company's financial status and obtain an estimate of the company's value. There are different systems to evaluate the financial performance of banks, and these systems use banking health criteria in line with the health of banks. In this regard, four main criteria of asset quality, liquidity, capital adequacy, and profitability and ten financial sub-criteria were extracted based on the frequency of the financial ratios used in the existing literature as well as the experts' opinions. In the next stage, using the data available in the banks' financial statements, these ten financial sub-criteria were calculated for all the banks in question in 2019.

Considering its advantages, the MEREC method was used to both weight the criteria of state-run banks, which are vital pathways of the country's economy, and calculate the weight of the criteria. The merits of the MEREC method include taking advantage of the effects of removing each of the criteria on the performance of the entire options to calculate the weight of the criteria, giving more weight to the criterion whose elimination leads to more effects on the performance of the entire options, helping decision makers to eliminate some criteria in the decision-making process, and not involving relative valuation and experts’ opinions.

The results obtained from the MEREC method showed that from among the financial ratios, the three ratios of cash and quasi-cash assets to total deposits, capital adequacy, and the net income of facilities and deposits to the balance of granted facilities had more weight and importance than other criteria. In addition, the state-run banks were in a good condition in terms of liquidity and were relatively acceptable in terms of asset quality, capital, and liquidity. Through using the weight of the criteria and the criteria calculated for the state-run banks, the researchers utilized MARICA, CODAS, and EDAS methods to rank the banks.

The reason for using several methods in combination is that each method is in a specific subgroup of multi-criteria decision-making compensation models. Furthermore, each of the methods has its own strengths and weaknesses, which can be used to combine the results of several methods and achieve the final result using the Borda and Copeland methods. Based on the selected criteria of this study in evaluating the financial performance and ranking of banks, the results of the rankings indicated that Export Development Bank of Iran and the Housing Bank ranked first and second respectively in the year of investigation. This shows that health standards were observed in these two banks compared to the other state-run banks.

In order to improve the health of state-run banks, it is suggested that the banks establish working groups to reform and restructure their financial structures so that a coherent financial plan is provided to reorganize the structure of their financial statements. These statements encompass

balancing assets and liabilities, reducing financial costs and increasing bank income, balancing cash flow, strengthening capital adequacy and its quality, to name just a few.

Based on the studied criteria, which are among the financial ratios in evaluating the performance of banks, future researchers are suggested to use other criteria, including other financial ratios in the banking health performance evaluation systems. Finally, the use of other different multi-criteria decision-making (MCDM) methods can be helpful in conducting such research in this field because they can weigh the criteria and rank the options in an individual or combined manner.

The findings in this study are subject to some limitations. One of the important issues in the present study was the selection of indicators used in the process of evaluating banks. As the selected banks are mainly development-specialized banks, the indicators used for commercial banks cannot be used for development-specialized banks. For example, in development-specialized banks, performance evaluation is not necessarily based on their profitability. Instead, the proper allocation of resources in the bank's mission areas is considered as one of the main indicators used in the sub-criteria examined in this study.

Another issue was access to information. In the country under review, access to historical data of state-run banks faces major limitations due to their non-disclosure. As mentioned before, the financial statements of these banks were published for the first time in 2019. Therefore, in addition to the lack of access to historical data and trends in these banks, another limitation in the implementation of this study was the lack of sufficient research background. This led to the fact that it was not possible to compare the results of the study with the results of the previous ones.

Finally, with regard to the implications of the study, it can be claimed that the obtained findings can be useful to the main users of the financial statements of state-run banks in Iran. At the international level, the findings can be effective for banks that intend to establish a brokerage relationship with state-run banks in Iran. In the same vein, the findings can be effective for the government in Iran and the managers of these banks to investigate and evaluate the performance of state-run banks.

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