

ORIGINAL ARTICLE

A HYBRID FRAMEWORK BASED ON PSI AND CRADIS METHODS FOR ASSESSING CORPORATE FINANCIAL PERFORMANCE

Yüksel AYDIN

Abstract

The aim of the present paper is to analyze corporate financial performance in the banking industry. For this purpose, the present manuscript presents a new hybrid decision-making model consisting of PSI and CRADIS procedures. In the developed decision-making model, PSI objective weighting methods are employed to assign significance weights to the criteria, while CRADIS, a relatively new algorithm, is utilized to rank bank financial performance. The proposed decision-making model was employed to evaluate the financial performance of Kuveyt Turk Participation Bank. Sensitivity and benchmarking analyzes were conducted to check the robustness of the introduced decision-making tool. According to the findings of the study, the most important criterion in determining the financial performance of the relevant participation bank is the ratio of total loans to total assets. Furthermore, the CRADIS technique's results show that, while financial instability is present in bank performance in general, there is a notable improvement in bank performance following 2015. Moreover, sensitivity and comparison analyzes prove that the integrated framework in this study is a powerful, reliable and useful decision tool that can be used in assessing the financial performance of banks.

Keywords

Banking industry, PSI, CRADIS, Financial performance

JEL Classification

C61, G21

Authors Notes:

Assoc. Prof. Dr., Sivas Cumhuriyet University, Faculty of Economics and Administrator Sciences, Department of Business Administration, ORCID: 0000-0001-8966-7781
yaydin@cumhuriyet.edu.tr

1. INTRODUCTION

In almost every economy, banks and insurance companies play an active role in managing the risks to which individuals and companies are exposed (Akgül et al., 2021; Çamlıbel, 2021; Çamlıbel, 2022; Işık et al. 2023). Although insurance companies have an increasing share in the financial system, banks remain the most dominant financial institutions in financial markets (Işık et al., 2024). This is especially true in developing economies where capital markets are not sufficiently developed.

Banks, which provide financial intermediation services between the units supplying funds and the units demanding funds in an economy, play an active role in both the development of financial markets and the creation of a stable economy (Shabir et al., 2021; Yazdi et al., 2020; Gupta et al., 2021)

The banking sector is one of the most important elements of economic life in today's business world where globalization and competition have reached macro levels, both in bank-oriented financial systems and market-oriented financial systems (Demir, 2021a; Nguyen et al., 2022).

Banks, which are regarded as the main source of financing for the real sector especially in developing economies, face many risks, especially credit and liquidity risks, during the financial intermediation process. Therefore, systematic or unsystematic risks that cannot be handled effectively may lead to deterioration in the financial performance of banks and the banking system (Karbassi Yazdi et al., 2022).

The financial performance of the banking sector, which has an extremely critical position in the economic system, is closely related to many stakeholders, like savers, real sector enterprises, and regulatory authorities. Performance evaluations using financial indicators are a very valuable tool in minimizing possible risks or negative shocks that may occur in financial markets (Işık, 2020; İç et al., 2022).

Moreover, the recent financial crisis, ongoing technological and social changes, the globalization of financial markets, and the new regulatory framework have led to increased uncertainty and complexity of financial decision-making problems (Işık, 2021).

Therefore, periodically analyzing the financial performance of the banking system contributes to the establishment of a strong and sound banking system and provides significant benefits to decision-making mechanisms in terms of effective management of potential risks. In addition, it is crucial to regularly assess the sustainability of banks' financial performance in order to promote sustainable economic development (Shabir et al., 2024). Furthermore, the impact of the COVID-19 pandemic and the recent financial and political crises has highlighted the need for a systematic assessment of the banks' financial performance (Xiazi and Shabir, 2022).

The current study seeks to offer a hybrid MCDM approach for evaluating and ranking company financial performance. The presented methodology has been implemented on a real case study and the financial performance of Kuveyt Turk Participation Bank, one of the leading banks in the participation banking industry, has been evaluated. The proposed methodology utilizes PSI technique to determine objective weights of financial criteria. The ranking of bank alternatives is estimated using the CRADIS approach.

The novelty and contributions of the present paper are as follows:

The existing manuscript introduces a methodological framework for solving financial performance measurement problems for decision makers in the banking industry.

In order to analyze bank financial performance, a real-world case study is performed that considers 10 criteria.

Managerial implications are provided for industry-related decision makers to improve the financial performance of the banking industry.

A comprehensive sensitivity and benchmarking study has been conducted to validate the proposed decision-making tool.

2. RELATED LITERATURE

The products and services provided by banks have vital impacts on the activities of all sectors of the economy. As a result, numerous studies have been conducted to measure and report on bank performance. In this context, a brief summary of some recent studies focusing on comparing the financial performance of banks is given in Table 1.

Table 1

MCDM studies concentrating on bank performance analysis

Study	Method	Aim	Criteria
Wu et al. (2009)	Fuzzy AHP, TOPSIS, VIKOR, and SAW	Performance evaluation based on BSC dimensions in the Taiwanese banking industry	23
Shaverdi et al. (2011)	Fuzzy AHP, ELECTRE, VIKOR, and TOPSIS	Performance assessment of Iranian banking industry	21
Stanujkić et al. (2013)	SAW, MOORA, GRA, VIKOR, and TOPSIS	Ranking of Serbian commercial banks	13
Wanke et al. (2016)	Fuzzy AHP, TOPSIS, neural network approach	Efficiency analysis of ASEAN banks based on CAMELS variables	25
Işık (2019)	Entropy and ARAS	Evaluation of the financial performance of the Deposit Banking Sector	8
Akgül (2019)	SAW, MAUT and ARAS	Analysis of Turkish banking industry performance	10
Akbulut (2019)	CRITIC and EDAS	Analysis of İşbank's performance	10
Koşaroğlu (2020)	SD and EDAS	Comparison of the performance of banks registered in Borsa Istanbul	8
Marjanović et al. (2020)	CRITIC and TOPSIS	Performance analysis in the Serbian banking industry	6
Aydin (2020)	SD and COPRAS	Performance assessment of Turkish deposit banking industry	8
Yazdi et al. (2020)	SWARA and WASPAS	Assessing the performance of Colombian banks based on BSC model	18
Işık (2020)	SD, MABAC and WASPAS	Comparison of the performance of state-owned development and investment banks	8
Akbulut (2020)	Grey Entropy, PSI and ARAS	Performance Analysis of Turkish Deposit Banks	12
Gupta et al. (2021)	AHP, TOPSIS and interval-valued TOPSIS	Performance evaluation in Iranian banking industry	10
Abdel-Basset et al. (2021)	AHP, COPRAS, VIKOR, and TOPSIS	Evaluation of commercial banks' performance in Egypt	19
Işık (2021)	PSI	Analysis of Akbank's financial performance	10
Demir (2021a)	ROC, ITARA, and CODAS	Assessing the financial performance of the Turkish banking industry	14
Demir (2021b)	SWARA and RAFSI	Performance analysis in privately owned deposit banks	10
Akgül (2021)	CRITIC and CoCoSo	Comparing the financial performance of listed banks	9
Gazel et al. (2021)	fuzzy Entropy and fuzzy TOPSIS	Assessment of commercial banks' performance in Turkey	34
Ünlü et al. (2022)	MEREC, SWARA II, and MARCOS	Analysis of productivity and efficiency in Turkish commercial banks	12

3. MULTI-CRITERIA METHODOLOGY

3.1. PSI Method

The calculation procedure of the PSI approach is carried out employing the following steps (Maniya and Bhatt, 2011):

Step 1. Decision matrix (D) is formed as shown in Equation (1).

$$D = [d_{ij}]_{m \times n} = \begin{bmatrix} d_{11} & d_{12} & \cdots & d_{1n} \\ d_{21} & d_{22} & \cdots & d_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ d_{m1} & d_{m2} & \cdots & d_{mn} \end{bmatrix}; i = 1, 2, \dots, m; j = 1, 2, \dots, n \quad (1)$$

Step 2. Matrix D is normalized using Equation 2 for beneficial criteria and Equation 3 for non-beneficial criteria.

$$d_{ij}^* = \frac{d_{ij}}{\max (d_{ij})} \quad (2)$$

$$d_{ij}^* = \frac{\min (d_{ij})}{d_{ij}} \quad (3)$$

Step 3. The average values for the elements in the normalized matrix are found via Equation (4).

$$\bar{d}_j^* = \frac{\sum_{i=1}^m d_{ij}^*}{m} \quad (4)$$

Step 4. Preference variation value ψ_j for each criterion is computed through Equation (5).

$$\psi_j = \sum_{i=1}^m (d_{ij}^* - \bar{d}_j^*)^2 \quad (5)$$

Step 5. Equation (6) is employed so as to compute the deviation Ω_j in preference value in terms of each criterion.

$$\Omega_j = |1 - \psi_j| \quad (6)$$

Step 6. Criteria weight values are computed with the help of Equation (7).

$$w_j = \frac{\Omega_j}{\sum_{j=1}^n \Omega_j} \quad (7)$$

3.2. The CRADIS method

The application of CRADIS procedure is explained below (Puška et al., 2022):

Step 1. The decision matrix (D) is formed as shown in Eq. (1).

Step 2. Matrix D is normalized employing Equation (8) for beneficial criteria and Equation (9) for non-beneficial criteria.

$$k_{ij} = \frac{d_{ij}}{d_{jmax}} \quad (8)$$

$$k_{ij} = \frac{d_{jmin}}{d_{ij}} \quad (9)$$

Step 3. The weighted normalized decision matrix is formed through the application of Equation (10):

$$n_{ij} = k_{ij} \times w_j \quad (10)$$

where w_j is the weight value of criterion j .

Step 4. Determination of ideal and anti-ideal solution. The ideal and anti-ideal solutions are the largest and smallest values in the weighted and normalized decision matrix, respectively.

$$y_i = \max n_{ij} \quad (11)$$

$$y_{ai} = \min n_{ij} \quad (12)$$

Step 5. Calculation of deviations from ideal and anti-ideal solutions.

$$t^+ = y_i - n_{ij} \quad (13)$$

$$t^- = n_{ij} - y_{ai} \quad (14)$$

Step 6. Calculation of the deviation of the individual alternatives from the ideal and anti-ideal solutions.

$$s_i^+ = \sum_{j=1}^n t^+ \quad (15)$$

$$s_i^- = \sum_{j=1}^n t^- \quad (16)$$

Step 7. Determination of the utility function for each alternative about the deviations from the optimal alternatives.

$$O_i^+ = \frac{b_0^+}{b_i^+} \quad (17)$$

$$O_i^- = \frac{b_0^-}{b_i^-} \quad (18)$$

where b_0^+ stands for the optimal alternative having the smallest distance from the ideal solution and b_0^- denotes the optimal alternative having the greatest distance from the anti-ideal solution.

Step 8: Ranking the decision alternatives.

$$P_i = \frac{O_i^+ + O_i^-}{2} \quad (19)$$

In the final step, the alternatives are assessed according to P_i values. Hence, the alternative having the highest value of P_i is determined as the best option.

4. REAL-WORLD CASE STUDY: ANALYZING THE FINANCIAL PERFORMANCE OF KUYEY TURK PARTICIPATION BANK

In this section, a real-life case study of Kuyey Turk Participation Bank, one of the leading banks in the Turkish participation banking sector, is presented. Within the scope of the study, the period 2009–2021 has been selected to analyze the financial performance of Kuyey Turk Participation Bank. For this purpose, each year was determined as an alternative. More specifically, A1 (2009), A2 (2010), A3 (2011), A4 (2012), A5 (2013), A6 (2014), A7 (2015), A8 (2016), A9 (2017), A10 (2018), A11 (2019), A12 (2020), and A13 (2021) represent the alternatives included in the analysis. In addition, the criteria utilized to evaluate the financial performance of the bank are C1 (ratio of total loans to number

of branches), C2 (ratio of total deposits to number of employees), C3 (ratio of profits share income to profit share expenses), C4 (ratio of total loans to total assets), C5 (ratio of loans disbursed to total funds), C6 (return on equity), C7 (capital adequacy ratio), C8 (ratio of number of personnel to number of branches), C9 (ratio of other expenses to total assets), and C10 (ratio of gross non-performing loans to total loans). For decision makers, the first 7 criteria are beneficial and the last 3 criteria are not beneficial.

4.1. The PSI method: Determination of weighting factors

The decision matrix including the decision alternatives and the selected criteria that we used to evaluate the performance of Kuveyt Turk participation bank in the period 2009-2021 is shown in Table 2.

Table 2
Decision Matrix

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
A1	41781.24	2189.72	208.50	77.60	94.35	15.75	14.56	20.22	5.51	5.90
A2	50037.50	2589.99	230.79	75.89	95.58	12.70	17.05	20.21	4.15	3.32
A3	57731.28	2982.06	227.03	66.58	104.77	13.56	16.02	18.48	3.63	2.02
A4	53762.90	3238.14	216.17	67.45	93.15	14.85	13.97	17.82	3.70	2.40
A5	62094.54	3668.83	236.19	65.77	97.71	13.05	14.24	17.32	3.42	2.29
A6	69109.31	4357.46	230.05	65.12	96.12	12.25	15.09	16.50	3.25	2.26
A7	75303.23	5167.71	234.01	66.88	96.13	13.07	14.23	15.16	3.37	1.64
A8	77608.77	5708.98	215.92	65.81	93.90	13.85	18.16	14.48	3.36	2.50
A9	95164.26	6932.93	224.32	69.77	95.27	14.68	17.66	14.41	3.51	1.88
A10	110518.77	9195.41	210.45	72.73	84.96	15.99	17.68	14.15	4.69	2.44
A11	134399.00	14356.74	187.93	81.86	67.75	16.27	19.32	13.82	4.41	3.21
A12	181733.44	20362.16	299.10	80.22	64.71	17.51	21.26	13.79	3.89	3.37
A13	279109.79	34584.28	241.18	83.48	58.16	23.92	23.05	13.88	3.05	2.27

The decision matrix is normalized employing Equation 2 for beneficial criteria and Equation 3 for non-beneficial criteria. The normalized decision matrix is indicated in Table 3.

Table 3
Normalized Decision Matrix

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
A1	0.1497	0.0633	0.6971	0.9296	0.9005	0.6582	0.6317	0.6820	0.5542	0.2775
A2	0.1793	0.0749	0.7716	0.9090	0.9123	0.5310	0.7397	0.6824	0.7352	0.4928
A3	0.2068	0.0862	0.7591	0.7975	1.0000	0.5669	0.6950	0.7465	0.8397	0.8122
A4	0.1926	0.0936	0.7228	0.8079	0.8891	0.6209	0.6061	0.7739	0.8248	0.6816
A5	0.2225	0.1061	0.7897	0.7878	0.9326	0.5453	0.6178	0.7963	0.8918	0.7137
A6	0.2476	0.1260	0.7691	0.7800	0.9174	0.5122	0.6547	0.8359	0.9375	0.7241
A7	0.2698	0.1494	0.7824	0.8011	0.9175	0.5463	0.6174	0.9099	0.9053	1.0000
A8	0.2781	0.1651	0.7219	0.7883	0.8963	0.5791	0.7879	0.9528	0.9082	0.6555
A9	0.3410	0.2005	0.7500	0.8358	0.9093	0.6136	0.7662	0.9573	0.8701	0.8703
A10	0.3960	0.2659	0.7036	0.8711	0.8109	0.6685	0.7670	0.9750	0.6505	0.6715
A11	0.4815	0.4151	0.6283	0.9806	0.6467	0.6801	0.8382	0.9983	0.6913	0.5095
A12	0.6511	0.5888	1.0000	0.9610	0.6176	0.7321	0.9223	1.0000	0.7841	0.4850
A13	1.0000	1.0000	0.8064	1.0000	0.5551	1.0000	1.0000	0.9941	1.0000	0.7220

The mean value for each criterion in the normalized matrix was found with the help of Equation 4. Next, the values for ψ_j , Ω_j , and w_j are calculated through Equations 5-7. Table 4 presents the results obtained by the PSI method. The objective weighting results calculated by the PSI method show that the three most critical criteria affecting the financial performance of Kuveyt Turk Participation Bank in the selected period are C4, C6, and C3, respectively.

Table 4*The Results of PSI method*

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
ψ	0.2693	0.3241	0.0867	0.0606	0.1538	0.0633	0.1165	0.1619	0.1591	0.4184
Ω_j	0.7307	0.6759	0.9133	0.9394	0.8462	0.9367	0.8835	0.8381	0.8409	0.5816
w	0.0893	0.0826	0.1116	0.1148	0.1034	0.1144	0.1079	0.1024	0.1027	0.0710

4.2. The CRADIS method: Evaluation of alternatives

For the application of the CRADIS algorithm, the initial decision matrix presented in Table 2 was utilized. this matrix was normalized as shown in Table 3 to obtain the normalized decision matrix. Then, a weighted normalized decision matrix is obtained as shown in Table 5. As seen in the last two rows of Table 5, the highest and lowest values of each criterion were found and then the maximum and minimum values were calculated via Equations 11 and 12.

Table 5*Weighted normalized decision-making matrix*

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
A1	0.0134	0.0052	0.0778	0.1067	0.0931	0.0753	0.0682	0.0698	0.0569	0.0197
A2	0.0160	0.0062	0.0861	0.1043	0.0943	0.0608	0.0798	0.0699	0.0755	0.0350
A3	0.0185	0.0071	0.0847	0.0915	0.1034	0.0649	0.0750	0.0764	0.0863	0.0577
A4	0.0172	0.0077	0.0806	0.0927	0.0919	0.0710	0.0654	0.0792	0.0847	0.0484
A5	0.0199	0.0088	0.0881	0.0904	0.0964	0.0624	0.0667	0.0815	0.0916	0.0507
A6	0.0221	0.0104	0.0858	0.0895	0.0948	0.0586	0.0707	0.0856	0.0963	0.0514
A7	0.0241	0.0123	0.0873	0.0919	0.0948	0.0625	0.0666	0.0932	0.0930	0.0710
A8	0.0248	0.0136	0.0805	0.0905	0.0927	0.0663	0.0850	0.0975	0.0933	0.0466
A9	0.0304	0.0166	0.0837	0.0959	0.0940	0.0702	0.0827	0.0980	0.0894	0.0618
A10	0.0353	0.0220	0.0785	0.1000	0.0838	0.0765	0.0828	0.0998	0.0668	0.0477
A11	0.0430	0.0343	0.0701	0.1125	0.0668	0.0778	0.0905	0.1022	0.0710	0.0362
A12	0.0581	0.0486	0.1116	0.1103	0.0638	0.0838	0.0995	0.1024	0.0805	0.0345
A13	0.0893	0.0826	0.0900	0.1148	0.0574	0.1144	0.1079	0.1018	0.1027	0.0513
Max.	0.0893	0.0826	0.1116	0.1148	0.1034	0.1144	0.1079	0.1024	0.1027	0.0710
Min.	0.0134	0.0052	0.0701	0.0895	0.0574	0.0586	0.0654	0.0698	0.0569	0.0197

Table 6 presents the results obtained using the CRADIS approach. When Table 7 is examined in detail, it is noted that the financial performance of Kuvveyt Turk participation bank is not stable over the years. If we divide the performance results into two groups, it has been determined that the results of the 2009-2014 period, which includes the global financial crisis, are worse than the 2015-2021 period, which includes the Covid-19 pandemic. Therefore, it can be concluded that it tends to improve bank performance in the 2015-2021 period. Moreover, the bank reached its highest financial performance during the pandemic period covering 2020 and 2021.

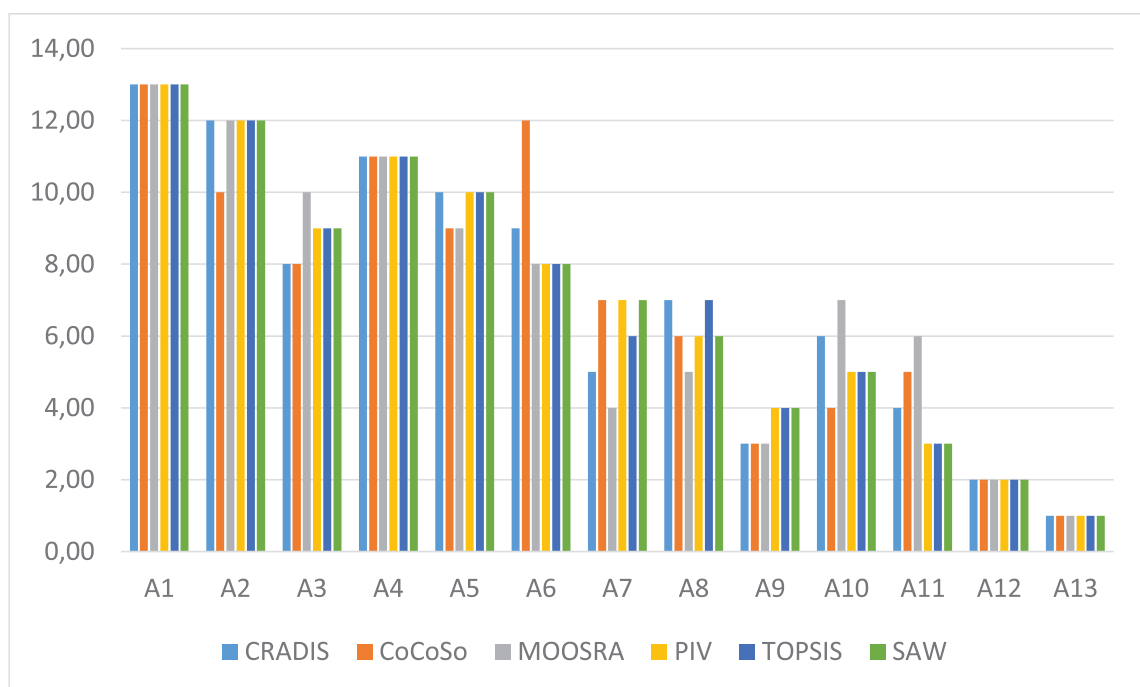
Table 6
The Results of CRADIS Method

	S^+	S^-	O^+	O^-	P	Rank
A1	0.5614	0.5338	0.2627	0.5632	0.4130	13
A2	0.5196	0.5756	0.2839	0.6073	0.4456	12
A3	0.4821	0.6131	0.3060	0.6470	0.4765	8
A4	0.5085	0.5867	0.2901	0.6191	0.4546	11
A5	0.4911	0.6042	0.3004	0.6375	0.4689	10
A6	0.4823	0.6130	0.3059	0.6468	0.4763	9
A7	0.4507	0.6445	0.3273	0.6801	0.5037	5
A8	0.4567	0.6385	0.3230	0.6737	0.4983	7
A9	0.4248	0.6704	0.3472	0.7074	0.5273	3
A10	0.4543	0.6409	0.3247	0.6763	0.5005	6
A11	0.4431	0.6521	0.3329	0.6881	0.5105	4
A12	0.3544	0.7408	0.4162	0.7817	0.5989	2
A13	0.2355	0.8598	0.6265	0.9072	0.7668	1
A	0.1475	0.9477				

4.3. Comparison with other MCDM techniques

In this subsection of the study, the results obtained from the CRADIS model were compared with those of the CoCoSo, MOOSRA, PIV, TOPSIS and SAW models. The results of the comparisons are presented in Figure 1. As seen in Figure 1, the ranking order of the 4 alternatives (A1, A4, A12 and A13) remained the same in all models. It is clear that there are minor deviations in the rankings of other alternatives. The presented comparative analysis confirms that, despite small changes in the positions of some alternatives, the first ranks of the alternative are reliable. This result is also supported by the results obtained from Spearman's rank correlation analysis. The average value of the Spearman correlation coefficients between the suggested CRADIS model and other MCDM models is 0.9637, which provides evidence that the initial orders of decision alternatives are robust and reliable.

Figure 1
Ranking of alternatives in terms of different MCDM models

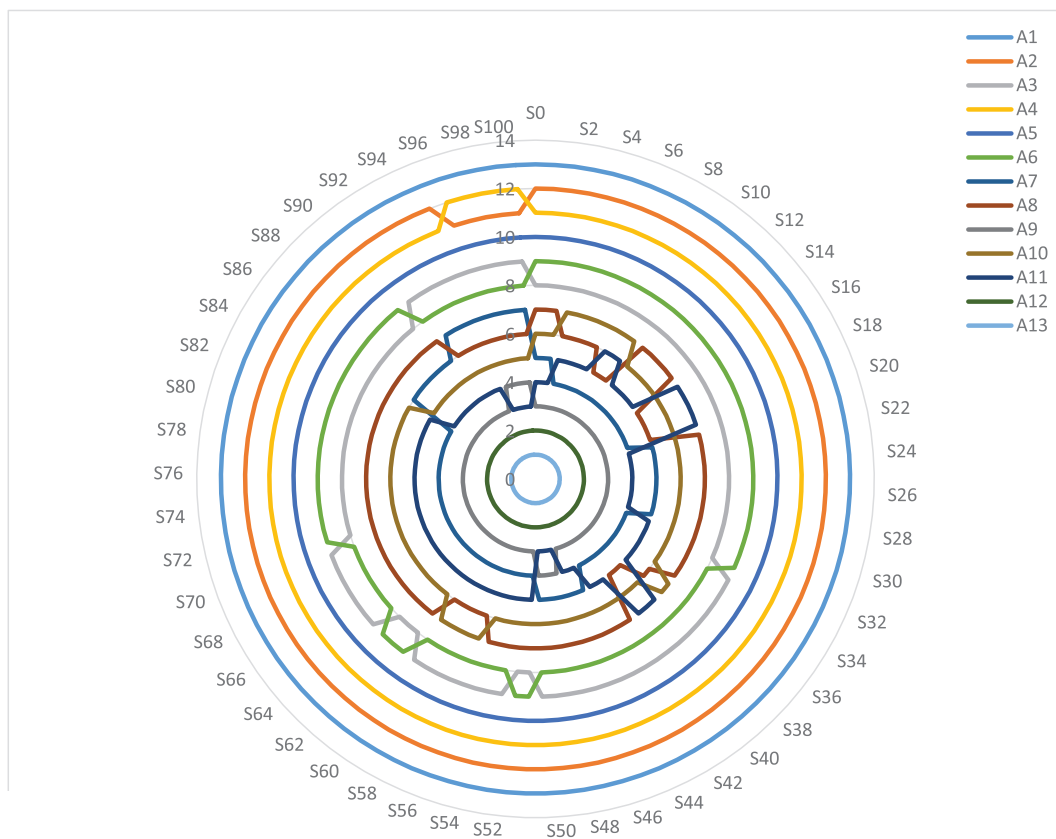


4.4. The influence of changing criterion values on the rankings of decision alternatives

The effect of changing criterion weight values on the rankings of alternatives was examined through 100 scenarios. In the first 10 scenarios, the weight of the C1 criterion was reduced by 10 percent in each scenario, and the weights were distributed to the remaining criteria so that the total value of the weights was 1. The same procedure was applied for all remaining criteria, resulting in a total of 100 new weight vectors from 100 scenarios. Figure 2 displays the ranking results obtained by applying the new weight vectors. Reviewing the results presented in Figure 2, it is observed that there are minimal changes in the ranking results. However, this minimal effect does not have a significant impact on the initial ranking orders of the alternatives. Therefore, the weight sensitivity analysis performed shows that the results obtained from the proposed model are robust, reliable and stable to the highest degree.

Figure 2

Re-ranking the alternatives according to new criterion weights



5. DISCUSSION AND POLICY IMPLICATIONS

Measuring and evaluating the performance of banks is of great importance for both the stability of the financial system and the sustainability of the economy. However, the inclusion of multiple criteria and alternatives in the decision-making process makes the performance evaluation process difficult. At this point, MCDM tools provide serious benefits to decision makers in terms of making correct and reliable decisions.

The evaluation framework proposed in the current article can first be used as a monitoring tool for the authorities that regulate and supervise the banking sector. Moreover, the proposed decision model

can help banks' boards and senior management to accurately evaluate bank performance. Thus, through this model, banks can identify their weaknesses and review and improve their business models to gain a competitive advantage in the industry. In addition, bank employees, bank customers and other bank stakeholders can improve their decision-making processes by evaluating the results of the proposed model in making more reliable decisions.

6. CONCLUSION, LIMITATIONS, AND FUTURE WORK

In the current article, a hybrid model consisting of PSI and CRADIS methods is proposed to analyze bank financial performance. The proposed model was applied to measure and evaluate the financial performance of Kuveyt Türk participation bank. The financial performance variables included in the decision-making process are the ratio of total loans to the number of branches, the ratio of total deposits to the number of employees, the ratio of profits share income to profit share expenses, the ratio of total loans to total assets, the ratio of loans disbursed to total funds, the return on equity, the capital adequacy ratio, the ratio of the number of personnel to the number of branches, the ratio of other expenses to total assets, and the ratio of gross non-performing loans to total loans, respectively. The decision alternatives are the financial years of the relevant bank. The study covers the period 2009-2021.

The objective weighting findings from the PSI technique demonstrate that the three most critical criteria influencing the financial performance of Kuveyt Turk Participation Bank in the selected period are the ratio of total loans to total assets, the return on equity, and the ratio of profits share income to profit share expenses, respectively.

The results obtained from the CRADIS technique show that although financial instability is observed in bank performance in general, a visible improvement in bank performance after 2015 is noteworthy. As a result, it can be stated that the performance of the relevant bank tends to improve over time depending on the developing and changing competitive conditions.

The first limitation of this study is that it focused on only a single bank. Another limitation can be explained by evaluating the performance of the relevant participation bank in the specified years. In future studies, the financial performance of commercial, participation or development and investment banks can be analyzed using different decision-making approaches. Additionally, more comprehensive evaluation results can be obtained by including financial variables as well as non-financial indicators in the analysis process. However, in future studies, the scope of the analysis can be expanded by using fuzzy or gray numbers in financial performance analysis. Finally, the proposed model can also be preferred in evaluating the performance of companies operating in other financial and non-financial sectors other than banking.

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