Qualis A3 ISSN: 2178-2008

ARTIGO

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Revista Processus de Estudos de Gestão, Jurídicos e Financeiros

A two steps AHP-PROMETHEEII application to assess banking financial performance

Uma aplicação em duas etapas do AHP-PROMETHEE II para avaliar o desempenho financeiro bancário

DOI: 10.5281/zenodo.15374625

Recebido: 20/02/2025 | Aceito: 26/04/2025 | Publicado *on-line*: 09/05/2025

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Abstract

This study with the objectif to assess the Algerian banking financial performance using the Analytic Hierarchy Process (AHP) and Preference Ranking Organization Method for Enrichment Evaluations (PROMETHEEII) combined approcach, with a sample comprise of 12 Banks which of whom 4 public banks and 8 private banks for a period span from 2019 to 2021. The approach used evaluate the banking financial performance using seven important financial pointers (NPM, ROE, ATR, CIR, LCR, DER and ICR) taking into account the banking main financial dimensions of Profitability, liquidity, operational efficiency leverage and solvency. The main results AHP-PROMETHEEII show that private banks outranked all the public banks during the period of analysis. Along with, the results of the sensitivity analysis largely align with the results of the PROMETHEEII, indicating the robustness of the ranking method.

Keywords: Financial performance, AHP, PROMTHEEII, Public banks, Private banks, Algerian banking.

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Resumo
Este estudo tem como objetivo avaliar o desempenho financeiro do setor bancário argelino por meio de uma abordagem combinada entre o Processo de Hierarquia Analítica (AHP) e o Método de Organização por Preferência para Avaliação Enriquecida (PROMETHEE II), utilizando uma amostra composta por 12 bancos — sendo 4 públicos e 8 privados — no período de 2019 a 2021. A abordagem utilizada avalia o desempenho financeiro bancário com base em sete indicadores financeiros relevantes (NPM, ROE, ATR, CIR, LCR, DER e ICR), levando em consideração as principais dimensões financeiras bancárias: lucratividade, liquidez, eficiência operacional, alavancagem e solvência. Os principais resultados do AHP-PROMETHEE II demonstram que os bancos privados superaram todos os bancos públicos durante o período analisado. Além disso, os resultados da análise de sensibilidade estão amplamente alinhados com os resultados do PROMETHEE II, indicando a robustez do método de classificação.

Palavras-chave: *Desempenho financeiro, AHP, PROMETHEE II, Bancos públicos, Bancos privados, Sistema bancário argelino.*

1. **Introduction**

In recent years, assessing and measuring banking performance is considered of the utmost importance for every country that seeks to better finance its economic system. Banks are considered a complementary to the financial markets, they are considered as crucial financial intermediaries providing a valuable financial service to the economic agents. Various studies confirmed the positive correlation between economic growth and a well functioning banking system [(Ferreira, 2016), (Is¸ıl & Erik, 2017)]. By mobilizing the needed funds and offering lines of credits, banks aide in turn the economic wheel of countries by helping them expend their business and by extension the overall economic dynamics. Banks are considered a superior manager of risks, where they serve as delegated risk monitors recognizing the linkage inherent among available assets in the market and provide hedging services and products for firms and enterprises (Hakenes, 2004). Also, banks are dynamically influencing in a direct and indirect manner the monetary policy, as they considered a conduit for the implementation of monetary policy by adjusting there lending activities to go with the adjusted interest rates set by the central bank [(Morris & Sellon, 1995), (Stein, 2012)]. Banks have a big role as a supporting based for international trade by providing the necessary financial instruments, foster corporate investments and reduce export risks, thus interlinking with national and international regulations and policy endeavors (Niepmann & Schmidt-Eisenlohr, 2015). Countless researches found a positive relationship between bank performance and economic growth indicating that a well-functioning banking are a crucial thing to a substantial growth in national income of any country [(King & Levine, 1993)]. Financial metrics play a preponderant role in asserting this relation, especially metrics related to Profitability, liquidity, operational efficiency and solvency [(Alam et al., 2021), (Reddy et al., 2023)].

In the Algerian context, the banking system has witnessed major transformations based on the new economic blueprint of the newly appointed president in 2019, which aims to diversify the economy away from the revenues generating from hydrocarbons (Oil and Gaz). In its earlier years post-independent, the Algerian banking arena was dominated by only public banking institutions and that was based on nationalized colonial commercial banks. from the beginning of the 1980's, the Algerian economy was struck by serious economic downturn which is the main inception is the

fall in the oil prices. In view of this conditions, the government was forced to make a drastic economic reform which included the banking system, which led to the law of bank and credit of 1986, then came the law of 1988 to remedy of some shortcomings of the precedent law. The Algerian banking arena in 2024 is comprised of 20 banks which of whom 6 public banks and 14 private banks working side by side to fulfill the financial needs for a tramendous economic transformation.

From the above, the main purpose of this research is to assess and evaluate the financial performance of Algerian banking system using a two-step approach based on AHP and PROMETHEE-II methods for the critical period of 2019 to 2021 that was characterized by the COVID-19 pandemic crisis, which fallowed by economic and financial downturn spiralling all over the world. Assessing banking financial performance can help curb and mitigate financial distress (Berger et al., 2000). Hence, evaluating banking performance considered a cornerstone behind a sound strategic decision-making process (Goddard et al., 2004). Evaluating banking financial performance aids in guiding regulatory policies, and by extension helps regulatory bodies to issue guidelines aimed at making the banking and financial system more resilient and more stable (Laeven & Levine, 2009). As a summary evaluating and assessing banking financial performance is crucial to any nation that seeks to elevate its financial and banking system and channel its capabilities to economic growth.

2. Theoratical framework

2.1. Key financial performance metrics

Profitability refers to how much a bank can generate profits and financial yields. As noted by Roengpitya et al. (2017), profitability is vital for a bank's sustainable success and development. Levine (2004) highlighted that following the 2008 financial crisis, profitability ratios played a crucial role in shaping regulatory frameworks, resulting in stricter scrutiny of the quality of bank earnings. To back this up, Dietrich and Wanzenried (2014) observed that profitability metrics like return on equity (RoE) provide understanding of a bank's earnings stability and its capacity to create systemic risks; They noted that steady profitability usually decreases the chances of financial trouble, leading regulators to pay close attention to profitability; They determined that regulatory frameworks need to incorporate profitability metrics to promote a more stable and resilient banking industry.

The second metric, operational efficiency, indicates a bank's ability to deliver high-quality financial services cost-effectively, ensuring the best use of resources to attain maximum results. Berger and Humphrey (1997) showed that operational efficiency is a significant indicator of stability in the banking sector. Consequently, regulators have been motivated to focus on enhancing processes and managing costs in their oversight approaches. Their results indicate that capable banks are more adept at managing and enduring economic difficulties. These findings align with the conclusions drawn by Resti (1997), who similarly recognized operational efficiency as an essential factor in assessing the overall well-being of banks. Resti contended that banks exhibiting lower efficiency are frequently faced with more stringent compliance requirements from regulators.

Liquidity, a crucial element of financial performance, reflects a bank's capability to meet its short-term financial responsibilities swiftly. Diamond and Dybvig (1983) highlighted the significance of efficient liquidity management for sustaining trust in financial markets. They noted that a lack of liquidity can cause bank runs, which further emphasizes the need for strict liquidity regulations. The Basel Committee on Banking Supervision (2013) reinforced this perspective by supplying empirical data from

financial crises, during which liquidity shortages intensified market instability. Their results have greatly shaped contemporary regulatory policies, placing liquidity evaluations as a key component in assessing banking performance.

The fourth metric, leverage, refers to how much a bank uses borrowed money to enhance its return on investment through asset financing. Adrian and Shin (2010) recognized high leverage as a significant factor in the 2008 worldwide financial crisis. This prompted regulatory bodies to enforce stricter limitations on leverage ratios. To address these issues, the Basel Committee on Banking Supervision (2011) implemented regulations on leverage ratios aimed at mitigating the risks associated with excessive leveraging. These measures illustrated how leverage evaluation can assist regulators in reducing the risk of systemic failures in the financial system.

Ultimately, solvency indicates a bank's capacity to fulfill its long-term commitments and maintain its functioning over an extended period. Merton (1974) highlighted the significance of solvency in assessing a bank's overall financial well-being. Altman and Saunders (1997) also demonstrated that assessments of solvency are crucial for establishing suitable capital reserves, which aid in cushioning potential losses in times of financial distress.

In summary, the combination of these five metrics—profitability, efficiency, liquidity, leverage, and solvency—offers a thorough method for assessing bank performance. These indicators provide crucial insights for stakeholders and function as vital tools for regulators and policymakers to establish effective oversight mechanisms and avert future financial crises.

2.2. Performance evaluation

Traditionally, the assessment of financial performance within the banking industry has mainly depended on the analysis of financial ratios (Arora, 2012; Najjar, 2013; Rehman et al., 2015; Yada et al., 2024). While financial ratios provide important insights into different aspects of performance, integrating them with statistical and mathematical models can lead to a more comprehensive and sophisticated grasp of banking performance. The scholarly work on performance measurement—especially regarding banking—features a wealth of research that examines the concept from various perspectives. Frequently utilized approaches consist of Data Envelopment Analysis (DEA), Stochastic Frontier Analysis (SFA), the CAMELS framework, and Multi-Criteria Decision Making (MCDM) methods. Of these, DEA has become extensively utilized as a non-parametric method for evaluating the efficiency of decision-making units (DMUs), including banks.

Data Envelopment Analysis (DEA), introduced by Charnes et al. (1978), is a linear programming-based technique used to solve optimization problems by analyzing inputs and outputs to assess the relative efficiency and performance of entities. A significant body of research has explored the application of DEA in evaluating banking performance. For instance, Seiford and Zhu (1999) applied DEA to a sample of the 55 largest U.S. banks to assess efficiency in terms of profitability and marketability. Their findings revealed that nearly 90% of the banks were inefficient in both areas, with larger banking conglomerates outperforming others in terms of profitability. Likewise, Havrylchyk (2006) analyzed the efficiency of banks in Poland between 1995 and 2004 and found that, on average, foreign banks outperformed domestic Polish banks in efficiency. In a different study, Kumar and Gulati (2010) evaluated the efficiency, effectiveness, and performance of 27 banks in the public sector of India. Their examination revealed that merely 15% of these banks operated at full efficiency, and that smaller banks typically surpassed their larger counterparts. Additionally, there is

significant literature that contrasts DEA with Stochastic Frontier Analysis (SFA). For instance, Chen (2002) assessed the technical efficiency of 39 banks in Taiwan using DEA and SFA, discovering only slight variations between the two approaches. More recently, Abidin et al. (2023) examined the performance of 71 Indonesian banks utilizing both DEA and SFA for the years 2018 and 2019, with both methods consistently showing that larger banks outperform smaller ones.

A commonly employed method for assessing the financial performance of banks is the CAMELS framework. Hasan et al. (2016) utilized this approach to evaluate the performance of 23 deposit banks in Turkey by integrating CAMELS with the MOORA method and Fuzzy Analytic Network Process (Fuzzy ANP). Their research emphasized capital adequacy as the most vital element affecting both banking stability and overall effectiveness. In a similar manner, Sah and Pokharel (2023) used the CAMELS framework to assess the financial performance of three commercial banks in Nepal during the period from 2011 to 2021. Their examination showed that all three banks exhibited robust capital adequacy and excellent asset quality, with Prime Commercial Bank Limited (PCBL) distinguishing itself due to its exceptional liquidity status

Researchers and scholars also employ Multiple Criteria Decision-Making (MCDM) techniques and their different adaptations to evaluate the performance of banking institutions. Multi-criteria decision-making (MCDM) is a part of the field of decision science which provide a strict methodology of assessing and ranking alternatives based on multiple criteria. It is extensively used in multiple domains of knowledge such as management, banking, finance and engineering for the purpose of assessing performance...etc. The integration of MCDM methods it's a widely used methodology among researchers, in the context of this article the use of analytic hierarchy process (AHP) in conjunction with preference ranking organization method for enrichment of evaluations (PROMETHEE-II) was motivated by several reasons:

- AHP and criteria weighing: AHP is a sound approach to derive consistent and objective weight for criteria (Saaty, 1980). But AHP is lacking the robust ranking mechanism;
- Using the PROMETHEE-II as a complementary robust ranking method to the AHP method, which considered a superb ranking method for decision making in a more complex setting (Brans & Mareschal, 2005).

By combining both AHP as a method to extract criteria optimal weight and PROMETHEE-II as a robust ranking evaluation and ranking method by incorporating preference threshold. Banking financial performance is based on five important metrics, Profitability, Efficiency, Liquidity, Leverage and solvency. The assessment of banking financial performance is considered crucial step for any countries that seeks to better it's economic system as the financial aspects considered the motor for any economic prosperity of any nation. Multi criteria methods, has been increasingly used in financial performance evaluations based on financial pointers.

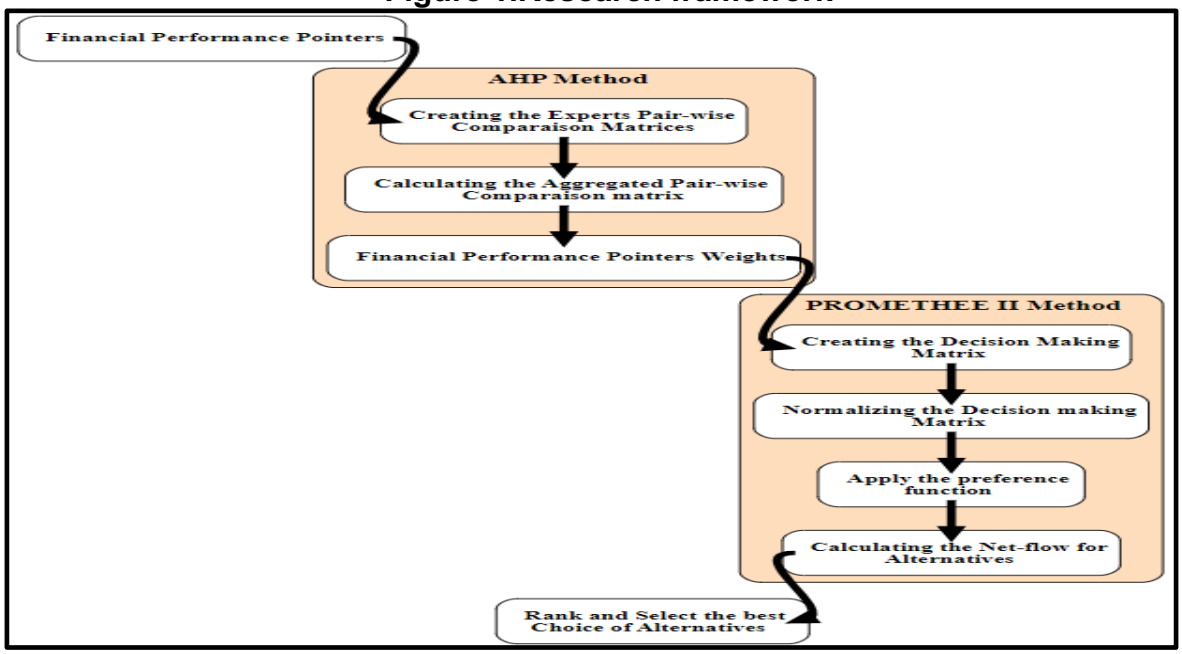
Analytic hierarchy process (AHP) is a widely used MCDM method especialy in measuring performance multiple studies confirmed the effectiveness of AHP in measuring performance. (Hunjak et al., 2001) developed a model based on the AHP method which combines quantitative financial ratios and qualitative factors in the context of Croatian banks, the study arrived that the developed framework gives a more holistic assessment of banking performance compared to traditional ranking method. (Bhandari & Nakarmi, 2014) evaluate the performance of Nepal commercial banks and rank them using a AHP method for the years in between 2008 to 2012. The study of (˙Ic¸ et al., 2021) used a AHP based VIKOR method to rank and select the best bank in the Turkish context, the study concluded to the importance of integrating

such an approach in helping decision makers to carry out performance evaluation to make sound economic and financial decisions.

The second method employed in this study is the preference ranking organization method for enrichment of evaluations (PROMETHEE-II). The study of (Kosmidou & Zopounidis, 2008) assesses the performance of the greek commercial and cooperative banks in the time span from 2003 to 2004 based on MCDM variant PROMETHEE, the results of the study indicate that Greek commercial banks are tending to increase their accounts and becoming more competitive and maximizing their profits, while the results for cooperative banks were not so uniform. (Uzar, 2013) used PROMETHEE to assess financial performance of three Turkish public banks within tow periods the first a pre-financial crisis from 2002 to 2007 and the second period a post financial crisis from 2008 to 2012, the results indicate a highly applicability of PROMETHEE in measuring and ranking banking entities. (Doumpos & Zopounidis, 2015) evaluate banking performance using the PROMETHEE-II method by combining financial and qualitative pointers, this study indicates the importance of the PROMETHEE-II method in addressing the complexity in bank rating. (George et al., 2022) analyze the performance of Indian private-sector banks using the PROMETHEE method for the period of 2018 and 2019, the study arrives to identify the best performing bank which is ICIC Bank and the second-best performer bank HDFC Bank.

In the Algerian context, extensive bibliographical research reveals only one study that applied an MCDM method, the (Yahiaoui & Zirmi, 2022) study was aimed to assess the financial performance of one Algerian bank (Bank of Algeria) by employing the MCDM variant TOPSIS for the period span from 2015 to 2019. The near absence of the Algerian banking literature in terms of comprehensive studies using MCDM methods is regarded as a major gap and a wasted opportunity for scholarly and practical applications. This study comes as a valuable contribution in assessing Algerian banking financial performance using a hybrid tow step AHP and PROMETHEE-II approach for the time span of 2019 to 2021, this study aspires to contribute to the Algerian banking literature regarding the use of MCDM methods and This study maybe the first comprehensive study of the Algerian banking system using MCDM approaches.

Figure 1.Research framework



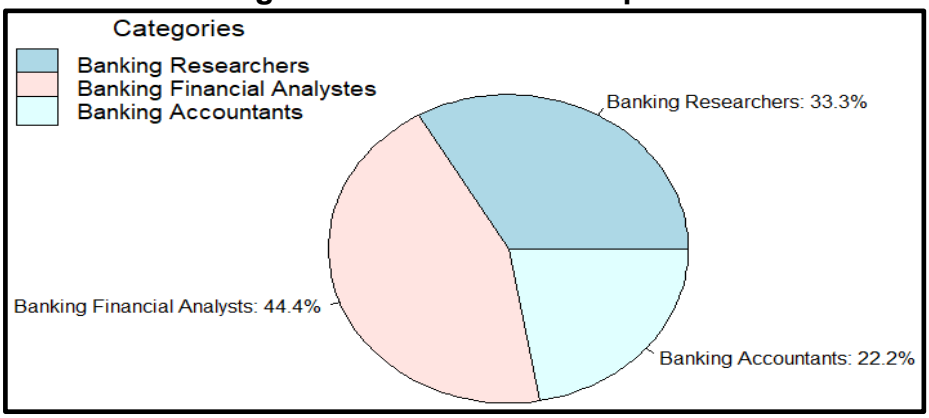
Source: Elaborated by the authors.

3. Methodolgy

3.1 Financial Performance Pointers

As a first step of this research, the financial performance indicators were determined based on the availability of banking data, banking literature and the opinion of 9 experts in the Algerian financial and banking system (Figure 2), 3 of these experts are banking researchers, 4 are banking financial analysts and 2 are banking accountants with more then 12 years of experience. A total of 7 financial performance indicators were selected (Table 1).

Figure 2.Distribution of experts



Source: Elaborated by the authors.

Table 1.Financial Performance Indicators

Shorten-ing	Financial Ratios	Equation	Ideal Value	Type of ratio
NPM	Net Profit Margin	$Net\ Profit/Revenue$	Max	PR(1)
ROE	Return on Equity	$Net\ Income/Average\ Shareholders\ Equity$	Max	PR
ATR	Asset Turn-over Ratio	$Revenue/Average\ Assets$	Max	ER(2)
CIR	Cost to in-come Ratio	$Operating\ Expenses/Operating\ Income$	Min	ER
LCR	Liquidity Coverage Ratio	$Liquid\ Assets/Total\ Assets$	Max	LR(3)
DER	Debt to Eq-uity Ratio	$Total\ Liabilities/Total\ Shareholders\ Equity$	Min	SR(4)
ICR	Interest Coverage Ratio	$Earnings\ Before\ Interest\ and\ Taxes\ (EBIT)/Interest\ Expenses$	Max	LR(5)

Note: This table is elaborated by the authors.
(1) PR=Profitability ratio. (2) ER=Efficiency ratio. (3) LR=Leverage ratio. (4) SR=Solvency ratio. (5) LR=Leverage ratio.

3.2 Data collection

The sample contains 12 total banks with 4 public banks and 8 private banks. The data is collected from the annaul available reports of each bank for the years 2019, 2020 and 2021. Details and abbreviation call name of each bank is listed in the fallowing Table 2.

Table 2. The Algerian bank study sample general information

N°	Bank	Code	Year established	Ownership
1	Al Baraka Bank	ABB	1991	Private
2	Alsalam Bank Algeria	ABA	2008	Private
3	Bank ABC Algeria	ABC	1998	Private
4	Banque Extérieure d'Algérie	BEA	1967	Public
5	Banque Nationale d'Algérie	BNA	1966	Public
6	BNP Paribas El Djazair	BNPP	2000	Private
7	CNEP-Banque	CNEP	1964	Public
8	Crédit Populaire d'Algérie	CPA	1966	Public
9	Fransabank El Djazair	FBA	2006	Private
10	Gulf Bank of Algeria	AGB	2003	Private
11	Société Générale Algérie	SGA	2000	Private
12	Trust Bank Algeria	TBA	2002	Private

Source: Elaborated by the author.

3.3 Mathematical modeling

3.3.1 Analytical Hirearchy Process (AHP)

The Analytical Hierarchy Process (AHP), was developed by Thomas L. Satty in the 1970's and culminated in it's works published in 1980 and 1990 [(Saaty, 1980), (Saaty, 1990)]. The application of AHP in the context of this research is done with the intention to calculate the weights of criteria using the Saaty's fundamental scale (See: Appendix n°2). This method involves multiple successive calculations illustrated in the fallowing mathematical steps:

A : Expert Pairwise comparison matrix construction

The construct of the aggregated pairwise comparison matrix was based on the judgment of 9 experts in the field of banking and finance, based on there judgment, 9 sub pair comparison matrices was extracted based on the results of a questionnaire. These matrices were utilized to create an aggregated pairwise comparison matrix with the use of the geometric mean.

Suppose we have k banking and financial experts. Every expert (e) will provide a one pairwise comparisonmatrix (A^e) of all the criterion where:

$$A^e = \left[a_{ij}^e\right] \tag{1}$$

- a_{ij}^e is the comparison between tow criterion's C_i and C_j.

B: Aggregated Pairwise Comparison Matrix

The aggregated pairwise comparison matrix is extracted by using the geometric mean aggregation method for each element in the experts pairwise comparison matrices (A^e) in accordance with the fallowing equation:

$$a_{ij} = \left(\prod_{e=1}^{k} a_{ij}^{(e)}\right)^{\frac{1}{k}} \tag{2}$$

The implementation of the equation (2) gives us the aggregates pairwise comparison matrix $A = \left[a_{ij}\right]$. This matrix then will be used further analysis to calculate the weight of the criteria.

C: Normalizing the Aggregated Pairwise Comparison Matrix

The process of normalization scales the values in any given matrix, this process often done to ensure that all features contribute to the analysis. Normalizing the aggregated matrix A by dividing each value a_{ij} by the sum of its columns:

$$A_{norm}(i,j) = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}} \tag{3}$$

D: Calculation of the weights (Priority Victor)

The weights of criteria or priority vector (w) is calculated by the averaging the rows of the normalized matrix (A_{norm}) using the fallowing equation (4):

$$w_j = \frac{\sum_{j=1}^{n} A_{norm}(i,j)}{n} \tag{4}$$

Where:

- n is the number of criteria and w_j is the priority vector (weights).

E: Consistency check for the original aggregated pairwise comparison matrix

First process to di is calculated the weighted pairwise comparison matrix based on the multiplication of the original aggregated pairwise comparison matrix (A) with the weight vector (w_i) in accordance with equation (5), the result is the aggrgated weighted matrix (C):

$$C = A[a_{ij}].w_i \tag{5}$$

The next step is calculating (λ_{max}) in accordance to equation (6):

$$\lambda_{max} = \frac{1}{n}\sum_{i=1}^{n}\left(\frac{(Aw)_i}{w_i}\right) \tag{6}$$

After calculating the (λ_{max}), the consistency index is to be determined using the fallowing equation (7):

$$CI = \frac{\lambda_{max} - n}{n-1} \tag{7}$$

By using the random index (RI) which linked to the number of criteria (n), finally we could calculate the consistency ratio (CR) fallowing the equation (8):

$$\mathrm{CR} = \frac{CI}{RI} \tag{8}$$

If:

- $CR > 0.10$ the judgment is not acceptable and need to be revised;
- $CR < 0.10$ the judgment of the pairwise comparison matrix considered good and acceptable.

3.3.2 Preference Ranking Organization Method for Enrichment of Evaluations (PROMETHEE-II)

The PROMETHEE first introduced by Jean-Pierre Brans and his colleagues in the 1980's (Brans et al., 1986). PROMETHEEII is the extension of PROMETHEE to provide a complete ranking making it one of the best methods in the decision analysis process. The process of calculating the performance and final ranking of banks under the study involves multiple mathematical steps depicted as fallows:

A: Define and determine the decision matrix

Let m be the alternatives (Banks) and m criteria (Financial ratios). The decision matrix D is as fallows:

$$D = \begin{pmatrix} d_{11} & d_{12} & \cdots & d_{1n} \\ d_{21} & d_{22} & \cdots & d_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ d_{m1} & d_{m2} & \cdots & d_{mn} \end{pmatrix} \tag{9}$$

- Where dij is the value of alternative i on criterion j.

B: Normalizing the decision matrix

To normalize the decision matrix (D), the most employed method in PROMETHEE-II is the minimum and maximum normalization method. We denote the normalized decision matrix as $N = [n_{ij}]$, where the normalization process is based on the fallowing equations:

- For the beneficial criteria (criteria to be maximized):

$$n_{ij} = \frac{d_{ij} - \min(d_j)}{\max(d_j) - \min(d_j)} \tag{10}$$

- For the non-beneficial or cost criteria (criteria to be minimized):

$$n_{ij} = \frac{\max(d_j) - d_{ij}}{\max(d_j) - \min(d_j)} \tag{11}$$

Where:

- $max\ (d_j)$ and $min\ (d_j)$ are the maximum and minimum value of the criterion j;
- n_{ij} is the normalized value for alternative i for every criterion j.

C: Apply the preference function and calculate the global preference index

The chosen preference function is based on the fallowing equations:

$$P_j(a_i, a_k) = 0 \text{ if } n_{a_ij} \leq n_{a_kj} \tag{12}$$

And:

$$P_j(a_i, b_k) = \left(n_{a_ij} - n_{a_kj}\right) \text{ if } n_{a_ij} > n_{a_kj} \tag{13}$$

Using the result of the equations (12) and (13) to calculate the preference index matrix $\pi(a_i, a_k)$, this preference aggregates the preference degrees weighted by the priority vector w_j calculated using the AHP method where $\sum w = 1$, the preference index matrix is calculated based on the fallowing equation:

$$\pi(a_i, a_k) = \sum_{j=1}^{m} w_j \cdot P_j(a_i, a_k)$$

D: Calculate the Net flow for alternatives

Calculating the net flow $\varphi(ai)$ by calculating the positive flow $\varphi^+(a_i)$ and $\varphi^-(a_i)$ using the fallowing equations:

- Positive flow $\varphi^+(a_i)$ or the leaving flow which measures and quantify the preference of one alternative over the others:

$$\varphi^+(a_i) = \frac{1}{n-1} \sum_{k \neq i} \pi(a_i, a_k) \tag{14}$$

- Negative flow $\varphi^-(a_i)$ or the entering flow which measures and quantify hox much alternatives are preferred over a_i:

$$\varphi^-(a_i) = \frac{1}{n-1} \sum_{k \neq i} \pi(a_k, a_i) \tag{15}$$

- Net flow $\varphi(ai)$ or the overall score:

$$\varphi(a_i) = \varphi^+(a_i) - \varphi^-(a_i) \tag{16}$$

E: Rank the alternatives

The calculated net flow performance score $\varphi(ai)$ is the bases for ranking the alternatives (the higher the better).

3.4 Experts pairwise comparison matrices

To derive and calculate the weights of criteria, nine different experts were asked to give their opinion and preferences with respect to different criteria.

$$A_1 = \begin{bmatrix} 1 & 2 & 4 & 5 & 8 & 7 & 9 \\ 1/2 & 1 & 3 & 4 & 6 & 5 & 7 \\ 1/4 & 1/3 & 1 & 2 & 4 & 3 & 5 \\ 1/5 & 1/4 & 1/2 & 1 & 3 & 2 & 4 \\ 1/8 & 1/6 & 1/4 & 1/3 & 1 & 4 & 3 \\ 1/7 & 1/5 & 1/3 & 1/2 & 1/4 & 1 & 3 \\ 1/9 & 1/7 & 1/5 & 1/4 & 1/3 & 1/3 & 1 \end{bmatrix} A_2 = \begin{bmatrix} 1 & 4 & 6 & 5 & 7 & 6 & 8 \\ 1/4 & 1 & 3 & 2 & 5 & 4 & 6 \\ 1/6 & 1/3 & 1 & 1/3 & 4 & 3 & 5 \\ 1/5 & 1/2 & 3 & 1 & 4 & 2 & 4 \\ 1/7 & 1/5 & 1/4 & 1/4 & 1 & 1/3 & 2 \\ 1/6 & 1/4 & 1/3 & 1/2 & 3 & 1 & 6 \\ 1/8 & 1/6 & 1/5 & 1/4 & 1/2 & 1/6 & 1 \end{bmatrix} A_3 = \begin{bmatrix} 1 & 4 & 5 & 3 & 7 & 5 & 7 \\ 1/4 & 1 & 3 & 2 & 5 & 4 & 6 \\ 1/5 & 1/3 & 1 & 1/4 & 4 & 2 & 5 \\ 1/3 & 1/2 & 4 & 1 & 5 & 3 & 5 \\ 1/7 & 1/5 & 1/4 & 1/5 & 1 & 1/3 & 2 \\ 1/5 & 1/4 & 1/2 & 1/3 & 3 & 1 & 4 \\ 1/7 & 1/6 & 1/5 & 1/5 & 1/2 & 1/4 & 1 \end{bmatrix}$$

$$A_4 = \begin{bmatrix} 1 & 4 & 6 & 4 & 7 & 5 & 9 \\ 1/4 & 1 & 3 & 2 & 5 & 3 & 7 \\ 1/6 & 1/3 & 1 & 1/6 & 3 & 2 & 4 \\ 1/4 & 1/2 & 6 & 1 & 5 & 3 & 6 \\ 1/7 & 1/5 & 1/3 & 1/5 & 1 & 1/5 & 2 \\ 1/5 & 1/3 & 1/2 & 1/3 & 5 & 1 & 4 \\ 1/9 & 1/7 & 1/4 & 1/6 & 1/2 & 1/4 & 1 \end{bmatrix} A_5 = \begin{bmatrix} 1 & 2 & 4 & 3 & 6 & 4 & 8 \\ 1/2 & 1 & 2 & 1/9 & 5 & 2 & 4 \\ 1/4 & 1/2 & 1 & 1/3 & 3 & 1 & 3 \\ 1/3 & 9 & 3 & 1 & 4 & 2 & 7 \\ 1/6 & 1/5 & 1/3 & 1/4 & 1 & 1/3 & 2 \\ 1/4 & 1/2 & 1 & 1/2 & 3 & 1 & 6 \\ 1/8 & 1/4 & 1/3 & 1/7 & 1/2 & 1/6 & 1 \end{bmatrix} A_6 = \begin{bmatrix} 1 & 5 & 6 & 4 & 9 & 6 & 7 \\ 1/5 & 1 & 2 & 2 & 4 & 3 & 5 \\ 1/6 & 1/2 & 1 & 1/4 & 3 & 2 & 4 \\ 1/4 & 1/2 & 4 & 1 & 5 & 3 & 8 \\ 1/9 & 1/4 & 1/3 & 1/5 & 1 & 1/3 & 2 \\ 1/6 & 1/3 & 1/2 & 1/3 & 3 & 1 & 3 \\ 1/7 & 1/5 & 1/4 & 1/8 & 1/2 & 1/3 & 1 \end{bmatrix}$$

$$A_7 = \begin{bmatrix} 1 & 4 & 5 & 3 & 7 & 6 & 9 \\ 1/4 & 1 & 3 & 2 & 5 & 3 & 6 \\ 1/5 & 1/3 & 1 & 1 & 4 & 2 & 4 \\ 1/3 & 1/2 & 1 & 1 & 5 & 4 & 6 \\ 1/7 & 1/5 & 1/4 & 1/5 & 1 & 1/3 & 2 \\ 1/6 & 1/3 & 1/2 & 1/4 & 3 & 1 & 8 \\ 1/9 & 1/6 & 1/4 & 1/6 & 1/2 & 1/8 & 1 \end{bmatrix} A_8 = \begin{bmatrix} 1 & 4 & 8 & 5 & 8 & 7 & 9 \\ 1/4 & 1 & 3 & 2 & 5 & 4 & 5 \\ 1/8 & 1/3 & 1 & 1/2 & 3 & 2 & 4 \\ 1/5 & 1/2 & 2 & 1 & 5 & 3 & 8 \\ 1/8 & 1/5 & 1/3 & 1/5 & 1 & 1/3 & 2 \\ 1/7 & 1/4 & 1/2 & 1/3 & 3 & 1 & 4 \\ 1/9 & 1/5 & 1/4 & 1/8 & 1/2 & 1/4 & 1 \end{bmatrix} A_9 = \begin{bmatrix} 1 & 4 & 6 & 4 & 7 & 5 & 8 \\ 1/4 & 1 & 3 & 2 & 5 & 3 & 6 \\ 1/6 & 1/3 & 1 & 1/3 & 3 & 2 & 4 \\ 1/4 & 1/2 & 3 & 1 & 5 & 4 & 7 \\ 1/7 & 1/5 & 1/3 & 1/5 & 1 & 1/2 & 3 \\ 1/5 & 1/3 & 1/2 & 1/4 & 2 & 1 & 5 \\ 1/8 & 1/6 & 1/4 & 1/7 & 1/3 & 1/5 & 1 \end{bmatrix}$$

3.5 Emperical results and discussion

3.5.1 Analytical hierarchy process (AHP) results

Aggregating the pairwise comparison matrices of experts need two main points:

- The need for reciprocity for each expert's matrix;
- Calculate the aggregated pairwise comparison matrix based on the geometric mean for each entry across all expert's matrices;
- Ensure consistency through the calculation of the consistency ratio (CR) which needs to be under 0.1 threshold (CR<0.1).

The geometric mean is calculated based on equation (2), the results of applying the geometric mean is the aggrgated pairwise comparaison matrix (X) that was represented in the fallowing Table (3):

Table 3.Aggregated pairwise comparaison matrix of experts

	ROE	ATR	LCR	ICR	DER	NPM	CIR
ROE	1	3.5150557	5.4363337	3.9148676	7.2890977	5.5855876	8.1834670
ATR	0.2844905	1	2.7415102	1.5667621	4.9773725	3.3408091	5.6998940
LCR	0.1839475	0.3647625	1	0.4175488	3.4091773	2.0263460	4.1733160
ICR	0.2554365	0.6382590	2.3949297	1	4.4955681	2.7937551	5.9273850
DER	0.1371912	0.2009092	0.2933259	0.2224413	1	0.4342138	2.1885750
NPM	0.1790322	0.2993287	0.4934991	0.3579412	2.3030130	1	4.5461400
CIR	0.1221976	0.1754419	0.2396176	0.1687084	0.4569184	0.2199668	1

Note. Number that are representing in this matrix are with 7 decimels but the number that are used are the entierty of the dicimels to preserve the reciprocity of the aggregated pairwise matrix.

The next stage is to calculate the weight of criterion and check the consistency of the aggregated pairwise comparison matrix, to achieve this we will follow multiple steps:

- Determine the priority vector (weights of criterion's) based on the aggregated pairwise comparison of experts by utilizing the eigenvector method;
- Calculating the consistency index (CI);
- Calculating the final consistency ratio (CR).

Normalizing the aggregated pairwise comparison matrix of experts through the use of equation (19) to ensure that comparison is proportionate.

Table 4. Normalized Aggregated Pairwise Comparaison Matrix

	ROE	ATR	LCR	ICR	DER	NPM	CIR
ROE	0.4624715	0.5675159	0.4314819	0.5118632	0.3045862	0.3626845	0.2580007
ATR	0.1315687	0.1614529	0.2175937	0.2048518	0.2079872	0.2169261	0.1797009
LCR	0.0850705	0.0588920	0.0793700	0.0545939	0.1424577	0.1315751	0.1315724
ICR	0.1181321	0.1030488	0.1900856	0.1307485	0.1878543	0.1814047	0.1868731
DER	0.0634470	0.0324374	0.0232813	0.0290839	0.0417865	0.0281945	0.0689993
NPM	0.0827973	0.0483275	0.0391690	0.0468003	0.0962350	0.0649322	0.1433264
CIR	0.0565129	0.0283256	0.0190185	0.0220584	0.0190930	0.0142829	0.0315271

After obtaining the normalized aggregated pairwise comparison matrix, the second step is to calculate the priority vector of criterion's using the equation (04), the resulting weights are as fallows:

Table 5. Priority Vector (Weights) for Criteria

Criteria	ROE	ATR	LCR	ICR	DER	NPM	CIR
Weights (w)	0.42407143	0.19009009	0.09449782	0.15554108	0.03903206	0.07032985	0.02643767
≈	0.4241	0.1901	0.0945	0.1555	0.0391	0.0703	0.0264

The second major step is to calculate the principal Eigenvalue (λ_{max}), the closer to n the higher the consistency. The condition to obtain (λ_{max}) is to calculate the weighted aggrgated comparaison matrix based by the based by the multiplication of the original aggregated matrix with the priority vector denoted (w) in accordance with equation (5), the result presented in the fallowing Table (6):

Table 6. Weighted aggregated pairwise comparison matrix

	ROE	ATR	LCR	ICR	DER	NPM	CIR
ROE	0.4240714	0.6681773	0.5137217	0.6089227	0.2845085	0.3928335	0.2163518
ATR	0.1206443	0.1900901	0.2590667	0.2436959	0.1942771	0.2349586	0.1506919
LCR	0.0780069	0.0693377	0.0944978	0.0649460	0.1330672	0.1425126	0.1103328
ICR	0.1083233	0.1213267	0.2263156	0.1555411	0.1754713	0.1964844	0.1567062
DER	0.0581789	0.0381908	0.0277187	0.0345988	0.0390321	0.0305382	0.0578608
NPM	0.0759224	0.0568994	0.0466346	0.0556746	0.0898913	0.0703299	0.1201893
CIR	0.0518205	0.0333498	0.0226433	0.0262411	0.0178345	0.0154702	0.0264377

The results of calculating (λ_{max}) in accordance to the equation (6), the results are as fallows:

Table 7.Wheighted Sum over Criteria Weight

	Wheighted Sum (I)	Criteria Wheights (II)	(I)/(II)
ROE	3.1085869	0.4240714	7.3303385
ATR	1.3934246	0.1900901	7.3303376
LCR	0.6927010	0.0944978	7.3303400
ICR	1.1401687	0.1555411	7.3303371
DER	0.2861182	0.0390321	7.3303307
NPM	0.5155416	0.0703299	7.3303332
CIR	0.1937971	0.0264377	7.3303313
		Sum (I)/(II)	51.3123483

Calculating (λ_{max}) as fallows:

$$\lambda_{max} = \frac{\sum(I/II)}{n} = \frac{51.3123483}{7}$$

$$\lambda_{max} = 7.3303355 \approx 7.33$$

The consistency index is a measure used in the (AHP) method as a major indicate of how coherent, consistent and reliable is the judgments of the chosen experts. Based on the equation (7) the consistency index (CI) as fallows:

$$CI = \frac{7.3303355 - 7}{7 - 1} \Rightarrow CI = 0.0550559$$

$$\Rightarrow \text{a good consistency as the CI is very close to zero}$$

Before calculating the final consistency ratio (CR) we need to identify the Random Index (RI). To identify the (RI) the fallowing table which enumerate the possible number based on the number of criterions which is in our case (n = 7):

Table 8. Random index (RI)

N	1	2	3	4	5	6	**7**	8	9	10
RI	0.00	0.00	0.58	0.9	1.12	1.24	**1.32**	1.41	1.45	1.49

With the random index (RI) of 1.32, the consistency ratio (CR) is calculated based on the equation (8) as fallows:

$$CR = \frac{0.0550559}{1.32} \Rightarrow CR = 0.041709 \Rightarrow CR < 0.1 \; which\; means\; a\; very\; good\; consistency$$

In all the consistency of the aggregated pairwise comparison matrix is very good based on the above indicators which we can proceed using the extracted weights of the criterions to the application of Preference Ranking Organization Method for Enrichment Evaluations (PROMETHEE-II).

3.5.2 PROMETHEE-II Results

To measure the financial performance and ranks the algerian banks sample, the normlization of the original decision matrices (See appendix: Table 20,21 and 22) for the years (2019 to 2021) it's at the most important in standarizing the data. Depending on the nature of the criterion being used (cost or benefit criterion) if:

- Cost criterion (the lower the better);
- Benefit criterion (the highest the better).

For the criteria beign used the ideal value is as fallows:

Table 9. Ideal value of the criteria

Criteria	ROE	ATR	LCR	ICR	DER	NPM	CIR
Ideal value	Max	Max	Max	Max	Min	Max	Min

Table 10, present the normalized decision matrix for the years (2019, 2020 and 2021). Normalizing the decision matrix is a crucial step in applying any MCDM variant. In all years, TRUSTB emerge as strong financial performers in two out of the three years and the CNEP bank consitently performs the worst in all years.

Table 10. Normalized decision matrix for the years 2019, 2020 and 2021

	Normalized decision matrix for the year 2019						
	ROE	**ATR**	**LCR**	**ICR**	**DER**	**NPM**	**CIR**
ABC	0.0478288	0.3562524	0.1472383	0.5235999	0.9867653	0.6986234	0.5719630
AGB	0.7055993	0.8232098	0.2232463	0.8761188	0.6346838	0.5977424	0.7821510
Alssalam	0.8276896	0.9423714	0.4384321	0.7618149	0.7353723	0.8946849	0.8846395
BEA	0.5275530	0.0585218	0.2050648	0.5490646	0.6232314	1	1
BNA	0	0.2613689	0.5441007	0.0457341	0.3300805	0.0542392	0.7782678
BNPP	0.4981818	0.8982829	0.7172427	0.9480626	0.5994934	0.3859770	0.5766016
CNEP	0.0223070	0.1476765	0.3079100	0	0	0	0
CPA	0.1985164	0	0.2902935	0.1648559	0.3589372	0.3848551	0.8476932
Elbaraka	1	0.4047714	1	0.4272850	0.4738280	0.9010145	0.9148540
FRANSB	0.2131288	0.8131165	0.4475669	0.4822901	0.9892725	0.7419313	0.8238860
SGA	0.3898485	0.9243871	0.8478668	0.3832291	0.5293873	0.2437052	0.6243318
TRUSTB	0.2188769	1	0.0129252	1	1	0.6261733	0.6964738
	Normalized decision matrix for the year 2020						
	ROE	**ATR**	**LCR**	**ICR**	**DER**	**NPM**	**CIR**
ABC	0.4476403	0.4375432	0	0.6360500	1	0.9228040	0.9295638
AGB	0.8613736	0.6924636	0.0316963	0.4705932	0.6006694	0.4843112	0.9031936
Alssalam	1	0.3483130	0.7363605	0.4335291	0.5880200	0.8327147	1
BEA	0.9377443	0.4403429	0.0625253	0.4620545	0.7171297	0.7796092	0.9457291
BNA	0.2869841	0.0177048	0.2086234	0.0548209	0.4056913	0.2985736	0.9657285
BNPP	0.3969100	0.6333675	0.8932299	0.6798938	0.6025751	0.2405099	0.6545143
CNEP	0	0.0867556	0.0226996	0	0	0	0
CPA	0.4178729	0	0.2260983	0.1326372	0.3350401	0.3944104	0.9895511
Elbaraka	0.9562583	0.2176640	0.9805550	0.2342822	0.4705723	0.6996932	0.9744856
FRANSB	0.2942204	0.3689638	0.2475000	0.4058334	0.9764453	0.7232539	0.9084014
SGA	0.5331352	1	1	0.2492904	0.5353920	0.1934650	0.7441835
TRUSTB	0.7745464	0.9337438	0.1635134	1	0.9921414	1	0.9290568
	Normalized decision matrix for the year 2021						
	ROE	**ATR**	**LCR**	**ICR**	**DER**	**NPM**	**CIR**
ABC	0.0554341	0.4562128	0.2825767	0.2382228	1	0.5291347	0.7317074
AGB	0.4444828	0.6003028	0.4320298	0.2396576	0.6828569	0.4174276	0.8172809
Alssalam	0.3884975	0.2790042	0.6470331	0.2306456	0.6701110	0.5609855	0.9123386
BEA	0.5144272	0.1218248	0.9036273	0.2417800	0.6792035	0.7882915	0.9928276
BNA	0.3799270	0.1581013	0.2684832	0.0776474	0.4770273	0.4035629	0.9891180
BNPP	0.2379218	0.8001630	0.8479434	0.6248129	0.6802559	0.1966304	0.6651929

CNEP	0.0368434	0.2961965	0.7070216	0	0	0	0
CPA	0.3651261	0	0.3836555	0.0946084	0.4454659	0.4236824	0.9541601
Elbaraka	0.5328993	0.1491479	1	0.1517007	0.5751679	0.5683310	0.8849489
FRANSB	0	0.4696480	0.4112512	0.1307808	0.9681143	0.3570321	0.7657242
SGA	0.6270552	0.8833824	0.9776468	0.3841260	0.6721119	0.4193833	0.8586434
TRUSTB	1	1	0	1	0.8204855	1	1

Appendix n°3, present the aggregated preference matrix for the years (2019, 2020 and 2021).

The results in Table n°11 and the graphical representation in Figure 3, reflect significant shifts in the rankings of Algerian banks over the three-year period (2019–2021) based on their net flow scores. In 2019, Alssalam ranked first with the highest net flow (0.6689), proceeded by Elbaraka (0.5948) and AGB (0.4599). However, Alssalam saw a constant fall in the succeeding years, dwindling to Rank 2 in 2020 and Rank 7 in 2021. In contrast, TRUSTB displayed impressive improvement, jumping from Rank 5 in 2019 to Rank 1 in both 2020 (0.6058) and 2021 (0.9528), making it the best-performing bank by the end of the study period. Simultaneously, SGA demonstrated a notable rise in 2021, gaining the second position with a net flow of 0.4847.

At the lower end, CNEP continually ranked last in all three years, with extremely negative net flow values, showing its fragile position relative to other banks. Likewise, BNA and CPA stayed among the worst-performing banks during the study period. The comprehensive results emphasize a dynamic banking landscape where some institutions, like TRUSTB and SGA, improved their rankings substantially, while others, like Alssalam, endured a decline. These results indicate that some banks composed better to shifting conditions, while others flailed to preserve their competitive edge.

Table 11. Final Flow and Ranking Table for the years of 2019, 2020 and 2021

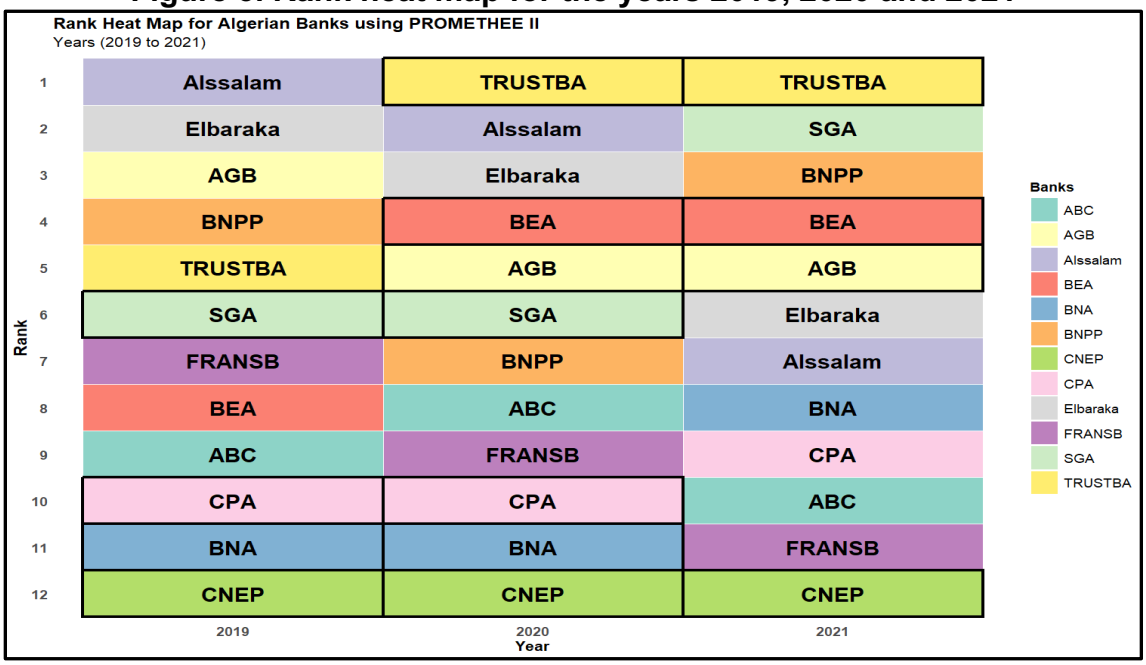
Final Flow and Ranking Table for the year 2019				
Bank	$\varphi^+(a)$ **Leaving Flow**	$\varphi^-(a)$ **Entering Flow**	$\varphi(a)$ **Net Flow**	**Rank**
ABC	0.1380656	0.5119573	-0.3738917	9
AGB	0.5786251	0.1187497	0.4598754	3
Alssalam	0.7253208	0.0564263	0.6688945	**1**
BEA	0.3278202	0.3476840	-0.0198638	8
BNA	0.0644505	0.7147262	-0.6502756	11
BNPP	0.5244271	0.1346510	0.3897761	4
CNEP	0.0194876	0.8274625	-0.8079749	**12**
CPA	0.0745642	0.6143465	-0.5397823	10
Elbaraka	0.7612609	0.1664781	0.5947827	2
FRANSB	0.2889521	0.2805064	0.0084457	7
SGA	0.3800189	0.2510759	0.1289431	6
TRUSTB	0.4245750	0.2835042	0.1410708	5
Final Flow and Ranking Table for the year 2020				
Bank	$\varphi^+(a)$ **Leaving Flow**	$\varphi^-(a)$ **Entering Flow**	$\varphi(a)$ **Net Flow**	**Rank**
ABC	0.2859519	0.3004377	-0.0144857	8
AGB	0.4572749	0.1636499	0.2936250	5
Alssalam	0.5710200	0.1158959	0.4551241	2
BEA	0.4692404	0.1506509	0.3185895	4
BNA	0.0503225	0.6343641	-0.5840416	11
BNPP	0.3537442	0.2958830	0.0578613	7
CNEP	0.0052940	0.9833862	-0.9780922	12
CPA	0.0887520	0.5317939	-0.4430419	10
Elbaraka	0.5129069	0.1896045	0.3233024	3
FRANSB	0.1773790	0.4039054	-0.2265264	9

SGA	0.4558579	0.2639286	0.1919293	6
TRUSTB	0.7049518	0.0991955	0.6057563	1

Final Flow and Ranking Table for the year 2021

Bank	$\varphi^{+}(a)$ Leaving Flow	$\varphi^{-}(a)$ Entering Flow	$\varphi(a)$ Net Flow	Rank
ABC	0.1332307	0.4381626	-0.3049319	10
AGB	0.2612785	0.1887318	0.0725467	5
Alssalam	0.1971913	0.2322496	-0.0350583	7
BEA	0.3105887	0.2097139	0.1008748	4
BNA	0.1189933	0.3595956	-0.2406023	8
BNPP	0.3783240	0.2458823	0.1324418	3
CNEP	0.0668473	0.6334839	-0.5666365	12
CPA	0.1126902	0.4003994	-0.2877091	9
Elbaraka	0.2950407	0.2226678	0.0723728	6
FRANSB	0.1107280	0.4915611	-0.3808331	11
SGA	0.5609349	0.0762336	0.4847014	2
TRUSTB	1.0630308	0.1101969	0.9528339	1

Figure 3. Rank heat map for the years 2019, 2020 and 2021



Source: Elaborated by the authors.

3.6 Sensitivity Analysis

Conducting sensitivity analysis for MCDM variants such as PROMETHEE-II is a crucial step for assessing the reliability and robustness of the methodology employed. Table (12) present the 7 scenarios employed for sensitivity analysis based on different weights for each scenario.

Table 12. Sensitivity analysis scenarios

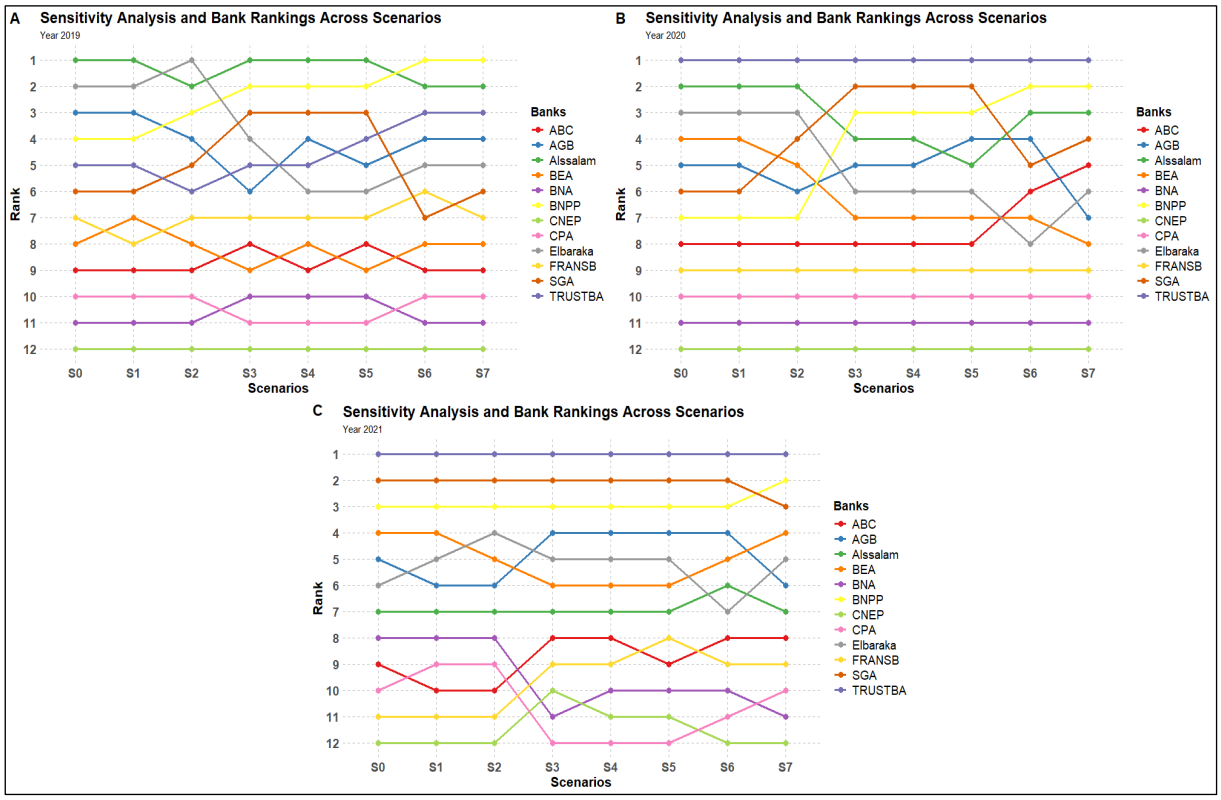
	ROE	ATR	LCR	ICR	DER	NPM	CIR
AHP-PRO	0.4241	0.1901	0.0945	0.1555	0.0391	0.0703	0.0264
Scenario 1	0.4241	0.1555	0.0945	0.1901	0.0391	0.0703	0.0264
Scenario 2	0.4241	0.1901	0.1555	0.0945	0.0703	0.0391	0.0264
Scenario 3	0.1555	0.4241	0.1901	0.0945	0.0391	0.0703	0.0264
Scenario 4	0.1901	0.4241	0.1555	0.0945	0.0703	0.0264	0.0391
Scenario 5	0.1901	0.4241	0.1555	0.0945	0.0391	0.0264	0.0703
Scenario 6	0.1555	0.1901	0.0945	0.4241	0.0391	0.0264	0.0703
Scenario 7	0.0945	0.1555	0.1901	0.4241	0.0703	0.0391	0.0264

Source: Elaborated by the authors.

Figure 4, present the ranking results of sensitivity analysis for the years (2019, 2020 and 2021), the results revealed the fallowing:

- **Stability and volatility**: Some banks exhibit stable rankings across various scenarios, signifying resiliency to parameter fluctuations. CNEP bank remains invariably among the lowest-ranked banks across all three years. In contrast, TRUSTB bank and Alssalam bank show strong performance but with some variations depending on the year and scenario;
- **Yearly trends**: In 2019 (Panel A), Alssalam preserves a high rank across most scenarios, while TRUSTB ranks mid-level. However, in 2020 (Panel B), TRUSTB improves significantly, consistently ranking as the best performer among the top banks. By 2021 (Panel C), TRUSTB still the powerful top-ranked bank, displaying increasing resilience across all scenarios;
- **Significant rank shift**: Banks, like SGA and BEA, experience rank fluctuations across scenarios, reflecting a high sensitivity to parameter fluctuations. Others, like ABC and BNA, persist in lower ranks with moderate variation;
- **General trends**: Over time, TRUSTB emerges as extremely resilient bank, steadily bettering its ranking. Concurrently, CNEP, CPA and BNA almost persistently rank at the bottom, displaying poor performance. This indicates that some banks continually perform well regardless of changing conditions, while others struggle to adapt.

Figure 4. Sensitivity analysis ranking results for the years of 2019, 2020 and 2021



Source: Elaborated by the authors.

4.Conclusion

This research examined the financial performance of Algerian banks both public and private using a hybrid AHP-PROMETHEEII procedure for the period of 2019 to 2021, while incorporating sensitivity analysis to evaluate the robustness of rankings under different weighting scenarios (7 scenarios). The results of the AHP-PROMETHEEII revealed the superiority of Alssalam bank in 2019 fallowed by Elbaraka bank in the second-best position while the three last positions were occupied by public banks (CNEP, BNA and CPA). A major change happened in 2020, with TRUSTBA bank surfacing as the best-performing bank, pushing from fifth place in 2019 to first, Alssalam bank remained strong by occuping the second position and similar to 2019 the public bank CNEP remained at the bottom rank fallowed by the tow public banks BNA and CPA which consitently showing poor performance. For the 2021, TRUSTBA bank maintained it's first palce rank revealing a continuous high performance. The private bank SGA strengthened its position from the sixth ranking in 2019 and 2020 to the second rank in 2021, while the BNPP bank ascend to the third position. Elbaraka bank which previously been in the first position in 2019 and in the first three position in 2020, fell to the sixth position in 2021. The CNEP bank remained at the lower bottom of ranking for the third time, while the tow private banks FRANSB and ABC fell to the eleventh and tenth position with a slight improvement of the financial performance of tow public banks BNA and CPA.

In both the PROMETHEEII and the sensitivity analysis results, TRUSTBA bank remains the top performing bank in both 2020 and 2021, substantiating the strong and steady performance of this banks across different scenarios. While Alssalam bank remained the top performer through all the different scenarios of 2019. The public bank CNEP consistently ranks last making it the worst performer bank in all of the years, while the other two public banks BNA and CPA appear in the lower ranks in both the results of the PROMETHEEII and the sensitivity analysis. However, the sensitivity analysis highlights the impact of weighting shift especialy for mid-tier banks like BNPP and BEA. The results of the sensitivity analysis largely align with the results of the PROMETHEEII, indicating the robustness of the ranking method. In all and based on the results of the study private banks revealed to be best financialy performers compares to public banks.

The finding of this study can provide a valuable insight for banks executives and policy makers in anhancing decision-making strategies. The implementation of sensitivity analysis stresses the soundness of rankings under changing circumstances, underpinning the validity of the adopted methodology. Though, the evaluation is restricted to financial ratios, which may not completely capture qualitative aspects such as client satisfaction and regulatory compliance. Future research routes in the Algerian context could use the mixe of financial and qualitative data by using more MCDM variants to furether enhance the evaluation process.

Limitations

This study is subject to several limitations that should be acknowledged. First, the sample size is limited to a subset of 12 banks out of 20 banks operating in the algerian market due to the unavailibility of complete financial data (annual reports) across all banking institutions. The exclusion of certain banks (8 banks) and years was necessary to maintain consistency and comparability in the datatset which can limite the generalizability of the results. Second, the chosen time frame of three years, can be sufficient to capture short-terme trends and ranking, but not fully reflect long-term performance patterns.

References

ABIDIN, Z.; PRABANTARIKSO, R. M.; FAHMY, E.; NABILA, A. Comparative efficiency using data envelopment analysis (DEA) and stochastic frontier analysis (SFA) in the banking industry. WSEAS Transactions on Business and Economics, v. 21, p. 109–120, Nov. 2023.

ADRIAN, T.; SHIN, H. S. Liquidity and leverage. Journal of Financial Intermediation, v. 19, n. 3, p. 418–437, 2010.

ALAM, M. S.; RABBANI, M. R.; TAUSIF, M. R.; ABEY, J. Banks' performance and economic growth in India: A panel cointegration analysis. Economies, v. 9, n. 1, p. 38, 2021. doi: 10.3390/economies9010038

ALTMAN, E. I.; SAUNDERS, A. Credit risk measurement: Developments over the last 20 years. Journal of Banking & Finance, v. 21, n. 11–12, p. 1721–1742, 1997.

ARORA, P. Financial performance measures, efficiency and Indian banking: Empirical evidence. International Journal of Productivity Management and Assessment Technologies (IJPMAT), v. 1, n. 2, p. 43–56, 2012.

Basel Committee on Banking Supervision. Basel III: A global regulatory framework for more resilient banks and banking systems: Revised version. 2011. Available at: https://www.bis.org/publ/bcbs189.pdf. Accessed in: 2024.

Basel Committee on Banking Supervision. Basel III: The liquidity coverage ratio and liquidity risk monitoring tools.2013. Available at: https://www.bis.org/publ/bcbs238.htm. Accessed in: 2024.

BERGER, A.; DEYOUNG, R.; GENAY, H.; UDELL, G. Globalization of financial institutions: Evidence from cross-border banking performance. Board of Governors of The Federal Reserve System, n. 2000–04. Available at: https://www.federalreserve.gov/pubs/feds/2000/200004/200004pap.pdf. Accessed in: 2024.

BERGER, A. N.; HUMPHREY, D. B. Efficiency of financial institutions: International survey and directions for future research. European Journal of Operational Research, v. 98, n. 2, p. 175–212, 1997. doi: 10.1016/S0377-2217(96)00342-6

BHANDARI, A.; NAKARMI, A. M. Performance evaluation of commercial banks in Nepal using AHP. In: Proceedings of the international symposium on the analytic hierarchy process (ISAHP). doi: 10.13033/ISAHP.Y2014.135, 2014.

BRANS, J.-P.; MARESCHAL, B. Promethee methods. In: FIGUEIRA, J.; GRECO, S.; EHRGOTT, M. (Ed.). Multiple criteria decision analysis: State of the art surveys. New York, NY: Springer, 2005. v. 78. DOI: 10.1007/0-387-23081-5_5

BRANS, J.-P.; VINCKE, P.; MEERS, Y. How to select and what to expect from PROMETHEE, the outranking method. European Journal of Operational Research, v. 24, n. 2, p. 228–238, 1986. doi: 10.1016/0377-2217(86)90059-4

CHARNES, A.; COOPER, W. W.; RHODES, E. Measuring the efficiency of decision-making units. European Journal of Operational Research, v. 2, n. 6, p. 429–444, 1978. doi: 10.1016/0377-2217(78)90138-8

CHEN, T.-y. A comparison of chance-constrained DEA and stochastic frontier analysis: Bank efficiency in Taiwan. The Journal of the Operational Research Society, v. 53, n. 5, p. 492–500, 2002. Available at : http://www.jstor.org/stable/823017

DIAMOND, D. W.; DYBVIG, P. H. Bank runs, deposit insurance, and liquidity. Journal of Political Economy, v. 91, n. 3, p. 401–419, June 1983. doi: 10.1086/261155

DIETRICH, A.; WANZENRIED, G. The determinants of commercial banking profitability in low-, middle-, and high-income countries. The Quarterly Review of Economics and Finance, v. 54, n. 3, p. 337–354, 2014. doi: 10.1016/j.qref.2014.03.001

DOUMPOS, M.; ZOPOUNIDIS, C. A multicriteria approach to bank rating. In: Bisdorff, R.; Dias, L.; Meyer, P.; Mousseau, V.; Pirlot, M. (Eds.), Evaluation and decision models with multiple criteria. Berlin, Heidelberg: Springer, 2015. doi: 10.1007/978-3-662-46816-6_19

FERREIRA, C. Does bank performance contribute to economic growth in the European Union? Comparative Economic Studies, v. 58, p. 174–195, 2016. doi: 10.1057/ces.2016.4

GEORGE, A. J.; MODI, A.; Ramachandran, M.; Raja, C.; Nanjundan, P. Evaluation of private banks using PROMETHEE method. Journal of Business and Banking, v. 1, n. 3, p. 42–50, 2022. doi: 10.46632/jbab/1/3/6

GODDARD, J. A.; MOLYNEUX, P.; WILSON, J. O. S. Dynamics of growth and profitability in banking. Journal of Money, Credit, and Banking, v. 36, n. 6, p. 1069–1090, 2004. doi: 10.1353/mcb.2005.0015

HAKENES, H. Banks as delegated risk managers. Journal of Banking & Finance, v. 28, n. 10, p. 2399–2426, 2004. doi: 10.1016/j.jbankfin.2003.09.007

HASAN, D.; UMIT, H.; SERHAT, Y. Performance assessment of deposit banks with CAMELS analysis using fuzzy ANP-MOORA approaches and an application on Turkish banking sector. Asian Journal of Research in Business Economics and Management, v. 6, p. 32–56, 2016. doi: 10.5958/2249-7307.2016.00009.8

HAVRYLCHYK, O. Efficiency of the Polish banking industry: Foreign versus domestic banks. Journal of Banking & Finance, v. 30, p. 1975–1996, 2006. doi: 10.1016/j.jbankfin.2005.07.009

HUNJAK, T.; JAKOVCEVIC, D.; BANKA, C. AHP-based model for bank performance evaluation and rating. In: Proceedings of the international symposium on the analytic hierarchy process (ISAHP), 2001. doi: 10.13033/ISAHP.Y2001.016

ISIL, G.; ERIK, E. Analysis of the effect of developments in the banking sector on economic development: The case of Turkey. In: ¨Ozatac¸, N.; G¨okmenoˇglu, K. (Eds.), New challenges in banking and finance. Springer, Cham, 2017. doi: 10.1007/978-3-319-66872-7_12

KING, R. G.; LEVINE, R. Finance and growth: Schumpeter might be right. The Quarterly Journal of Economics, v. 108, n. 3, p. 717–737, 1993. doi: 10.2307/2118406

KOSMIDOU, K.; ZOPOUNIDIS, C. Measurement of bank performance in Greece. South-Eastern Europe Journal of Economics, v. 6, n. 1, p. 79–95, 2008. Available at: https://EconPapers.repec.org/RePEc:seb:journl:v:6:y:2008:i:1:p:79-95 .

KUMAR, S.; GULATI, R. Measuring efficiency, effectiveness, and performance of Indian public sector banks. International Journal of Productivity and Performance Management, v. 59, n. 1, p. 51–74, 2010. doi: 10.1108/17410401011006112

LAEVEN, L.; LEVINE, R. Bank governance, regulation, and risk-taking. Journal of Financial Economics, v. 93, n. 2, p. 259–275, 2009.

LEVINE, R. The corporate governance of banks: A concise discussion of concepts and evidence. Policy Research Working Paper, n. 3404, World Bank, 2004. Available at: https://documents1.worldbank.org/curated/pt/657281468780585802/pdf/WPS3404.pdf

MERTON, R. C. On the pricing of corporate debt: The risk structure of interest rates. The Journal of Finance, v. 29, n. 2, p. 449–470, 1974. doi: 10.1111/j.1540-6261.1974.tb03058.x

MORRIS, C. S.; SELLON, G. H. Bank lending and monetary policy: Evidence on a credit channel. Economic Review, Federal Reserve Bank of Kansas City, v. 80, Q II, p. 59–75, 1995.

NAJJAR, N. J. Can financial ratios reliably measure the performance of banks in Bahrain? International Journal of Economics and Finance, v. 5, n. 3, p. 152, 2013. doi: 10.5539/ijef.v5n3p152

NIEPMANN, F.; SCHMIDT-EISENLOHR, T. International trade, risk, and the role of banks. International Finance Discussion Papers (IFDP), Nov. 2015. doi: 10.17016/IFDP.2015.1151

REHMAN, A.; JINGDONG, L.; Du, Y.; KHATOON, R.; NISAR, S. K. Financial performance, ratio analysis and evaluation of Agricultural Bank of China. International Journal of Economic Behavior and Organization, v. 3, n. 5, p. 69–73, 2015. doi: 10.11648/j.ijebo.20150305.1122

RESTI, A. Evaluating the cost-efficiency of the Italian banking system: What can be learned from the joint application of parametric and non-parametric techniques.

Journal of Banking & Finance, v. 21, n. 2, p. 221–250, 1997. doi: 10.1016/S0378-4266(96)00036-2

ROENGPITYA, R.; TARASHEV, N.; TSATSARONIS, K.; VILLEGAS, A. Bank business models: Popularity and performance. BIS Working Papers, n. 682, 2017. Available at: https://www.bis.org/publ/work682.pdf

SAH, G. K.; POKHAREL, S. Analysis of financial performance of Nepalese commercial banks using CAMEL approach. Cognition, 2023. doi: 10.3126/cognition.v5i1.55405

SAATY, T. L. How to make a decision: The analytic hierarchy process. European Journal of Operational Research, v. 48, n. 1, p. 9–26, 1990. doi: 10.1016/0377-2217(90)90057-I

SAATY, T. L. The analytic hierarchy process: Planning, priority setting, resource allocation. New York : McGraw-Hill, 1980.

SEIFORD, L. M.; ZHU, J. Profitability and marketability of the top 55 U.S. commercial banks. Management Science, v. 45, n. 9, p. 1270–1288, 1999. doi: 10.1287/mnsc.45.9.1270

STEIN, J. C. Monetary policy as financial stability regulation. The Quarterly Journal of Economics, v. 127, n. 1, p. 57–95, Feb. 2012. doi: 10.1093/qje/qjr054

UZAR, C. Financial performance test of public banks in Turkey: An application of PROMETHEE. International Journal of Economics and Finance, v. 5, n. 2, p. 1–9, 2013. Available at: https://dergipark.org.tr/tr/download/article-file/256767

YAHIAOUI, A.; ZIRMI, N. Evaluating the financial performance in banks using the TOPSIS method: A case study of National Bank of Algeria. Journal of Economics and Sustainable Development, v. 5, n. 1, 2022. Available at: https://dspace.univ-eloued.dz/items/c4375e5c-fe84-4fe4-8038-136eff085338

YADA, L. S.; LAKSHMI, T. V.; ANJALI, K. Financial performance analysis of ICICI Bank using ratio analysis. International Research Journal of Advanced Engineering and Management (IRJAEM), v. 2, n. 05, May 2024. doi: 10.47392/IRJAEM.2024.0244

İÇ, Y. T.; CELIK, B.; KAVAK, S.; Baki, B. Development of a multi-criteria decision-making model for comparing the performance of Turkish commercial banks. Journal of Advances in Management Research, v. 18, n. 2, p. 250–272, 2021. doi: 10.1108/JAMR-05-2020-0083

APPENDICES

Appendix 1. Decision matrix for the years of 2019, 2020 and 2021

Decision matrix for the year 2019

Banks	RoE	ATR	LCR	ICR	DER	NPM	CIR
ABC	0.0721716	0.0616561	0.1298987	3.5441231	2.9318297	0.3071031	1.2236880
AGB	0.1890811	0.0841779	0.1509469	5.7287966	7.0766477	0.2749316	0.7588931
Alssalam	0.2107810	0.0899251	0.2105363	5.0204181	5.8913098	0.3696281	0.5322572
BEA	0.1574359	0.0472963	0.1459120	3.7019360	7.2114696	0.4032136	0.2771571
BNA	0.0636707	0.0570798	0.2397980	0.5826342	10.662538	0.1016056	0.7674802
BNPP	0.1522155	0.0877987	0.2877446	6.1746553	7.4909210	0.2073986	1.2134305
CNEP	0.0676354	0.0515963	0.1743920	0.2992051	14.5483529	0.0843085	2.4884869
CPA	0.0989542	0.0444737	0.1695136	1.3208704	10.3228273	0.2070408	0.6139576
Elbaraka	0.2414067	0.0639962	0.3660460	2.9472281	8.9702945	0.3716466	0.4654430
FRANSB	0.1015513	0.0836911	0.2130659	3.2881126	2.9023137	0.3209142	0.6666034
SGA	0.1329608	0.0890577	0.3239172	2.6742000	8.3162333	0.1620273	1.1078833
TRUSTBA	0.1025730	0.0927046	0.0891254	6.4965284	2.7760265	0.2839984	0.9483537

Decision matrix for the year 2020

Banks	RoE	ATR	LCR	ICR	DER	NPM	CIR
ABC	0.0922557	0.0698759	0.1202075	4.4056649	2.8107421	0.3528781	0.8484194
AGB	0.1447874	0.0846003	0.1292206	3.3025574	7.4572444	0.2073721	0.9430190
Alssalam	0.1623888	0.0647218	0.3295960	3.0554491	7.6044292	0.3229836	0.5957385
BEA	0.1544842	0.0700376	0.1379870	3.2456296	6.1021434	0.3053615	0.7904283
BNA	0.0718572	0.0456256	0.1795308	0.5305856	9.7259565	0.1457384	0.7186832
BNPP	0.0858145	0.0811869	0.3742027	4.6979731	7.4350696	0.1264710	1.8351240
CNEP	0.0354188	0.0496140	0.1266623	0.1650926	14.4464693	0.0466621	4.1831103
CPA	0.0884762	0.0446029	0.1844999	1.0493905	10.5480343	0.1775401	0.6332225
Elbaraka	0.1568350	0.0571754	0.3990342	1.7270619	8.9710180	0.2788428	0.6872681
FRANSB	0.0727760	0.0659146	0.1905856	2.8708010	3.0848187	0.2866610	0.9243367
SGA	0.1031110	0.1023639	0.4045635	1.8271222	8.2167940	0.1108600	1.5134474
TRUSTBA	0.1337630	0.0985369	0.1667035	6.8321347	2.9021822	0.3784942	0.8502383

Decision matrix for the year 2021

Banks	RoE	ATR	LCR	ICR	DER	NPM	CIR
ABC	0.0620510	0.0649455	0.1720475	2.7482714	2.5026741	0.2844762	1.2409314
AGB	0.1347796	0.0715976	0.2324065	2.7635627	7.5207833	0.2362970	0.9594057
Alssalam	0.1243137	0.0567644	0.3192391	2.6675151	7.7224596	0.2982135	0.6466781
BEA	0.1478550	0.0495079	0.4228687	2.7861829	7.5785913	0.3962504	0.3818797
BNA	0.1227116	0.0511827	0.1663557	1.0369073	10.7775953	0.2303172	0.3940840
BNPP	0.0961652	0.0808245	0.4003798	6.8684298	7.5619391	0.1410674	1.4597554
CNEP	0.0585756	0.0575581	0.3434663	0.2093653	18.3255297	0.0562608	3.6481538
CPA	0.1199447	0.0438837	0.2128698	1.2176731	11.2769867	0.2389947	0.5090909
Elbaraka	0.1513081	0.0507694	0.4617903	1.8261447	9.2247311	0.3013816	0.7367867
FRANSB	0.0516881	0.0655658	0.2240148	1.6031867	3.0071977	0.2102485	1.1290205
SGA	0.1689096	0.0846665	0.4527626	4.3032624	7.6907995	0.2371406	0.8233284
TRUSTBA	0.2386278	0.0900503	0.0579244	10.8670594	5.3431066	0.4875601	0.3582835

Appendix 2.Saaty's fundamental scale for AHP

Numeric value	Verbal Judgement	Explanation

1	Equal importance	Both elements contribute equally to the objective.
3	Moderate importance	Experience or judgment slightly favors one element over another.
5	Strong importance	Experience or judgment strongly favors one element.
7	Very strong	One element is strongly favored and dominance is demonstrated in practice.
9	Extreme importance	One element is favored with the highest possible level of affirmation.
2,4,6,8	Intermediate values	Used to express values between two adjacent judgments above.

Note: The reciprocal is used for inverse comparisons. For example, if A is strongly more important than B (score 5), then B is 1/5 compared to A. Source from (Saaty, 1980).

Appendix 3. Aggregated preference matrix for the years 2019, 2020 and 2021

	ABC	AGB	Alssalam	BEA	BNA	BNPP	CNEP	CPA	Elbaraka	FRANSB	SGA	TRUSTB
ABC	0	0.0208583	0.0098295	0.0708128	0.1836063	0.0075486	0.2346895	0.1701143	0.0350328	0.0064237	0.0716919	0.0177858
AGB	0.4352775	0	0.0177743	0.2738995	0.5853962	0.1096553	0.6419259	0.5078951	0.1556283	0.2720158	0.2437266	0.2285562
Alssalam	0.5287582	0.1222838	0	0.3548283	0.6695707	0.1973327	0.7384347	0.6043384	0.1644435	0.3410152	0.3086673	0.3222518
BEA	0.2453623	0.0340299	0.0104492	0	0.3858060	0.0677280	0.4207227	0.2680133	0.0339849	0.1665224	0.1509423	0.1833598
BNA	0.0429499	0.0303207	0.0099857	0.0706001	0	0.0053240	0.0883100	0.0736710	0	0.0091224	0.0040639	0.0523554
BNPP	0.4140265	0.0721413	0.0553091	0.2700836	0.5228855	0	0.5964111	0.4694716	0.1797110	0.2349931	0.1465186	0.1850112
CNEP	0.0151835	0.0080007	0	0.0266672	0.0094604	0	0	0.0297381	0	0	0	0.0278761
CPA	0.0847046	0.0080663	0	0.0080541	0.1289177	0.0071568	0.1638344	0	0	0.0006285	0.0158196	0.0302035
Elbaraka	0.5169057	0.2230820	0.1273877	0.3413082	0.6225292	0.2846787	0.7013788	0.5672825	0	0.3995021	0.3338711	0.4496394
FRANSB	0.1951280	0.0463010	0.0107907	0.1806771	0.3384831	0.0467923	0.4082103	0.2747425	0.1063336	0	0.0736790	0.0525751
SGA	0.3206449	0.0782604	0.0386916	0.2253458	0.3936733	0.0185665	0.4684590	0.3501822	0.1009513	0.1339277	0	0.1514110
TRUSTB	0.2728027	0.0691539	0.0583399	0.2638271	0.4480287	0.0631229	0.5023989	0.3706300	0.2227835	0.1188877	0.1574749	0

Aggregated preference matrix for the year 2020

	ABC	AGB	Alssalam	BEA	BNA	BNPP	CNEP	CPA	Elbaraka	FRANSB	SGA	TRUSTB
ABC	0	0.0728646	0.0708964	0.0481831	0.3054476	0.0922806	0.4839484	0.2372280	0.1406592	0.1294091	0.1344739	0.0003207
AGB	0.2269200	0	0.0716811	0.0492559	0.4572039	0.2319176	0.6358586	0.3889843	0.1320925	0.3120972	0.2008152	0.0368234
Alssalam	0.3057013	0.1524307	0	0.0952461	0.5195829	0.3065233	0.7166082	0.4490830	0.0889873	0.3599384	0.2803970	0.1516218
BEA	0.2147207	0.0617381	0.0269788	0	0.4656498	0.2794337	0.6483409	0.3974302	0.0930083	0.3001773	0.2583122	0.0696524
BNA	0.0206697	0.0183705	0	0.0143342	0	0.0122979	0.2101519	0.0061281	0	0.0015134	0.0132379	0.0052310
BNPP	0.1284541	0.1140357	0.1078918	0.1490696	0.3332494	0	0.5179768	0.2790061	0.1534791	0.1974517	0.0728929	0.0689582
CNEP	0.0021451	0	0	0	0.0131266	0	0	0.0164922	0	0	0	0
CPA	0.0229500	0.0206508	0	0.0166145	0.0766280	0.0285545	0.2840174	0	0.0003977	0.0545834	0.0206042	0.0075113
Elbaraka	0.3095533	0.1469312	0.0230764	0.0953648	0.4536720	0.2861997	0.6506973	0.3835699	0	0.3517886	0.2211144	0.1554738
FRANSB	0.0233888	0.0520214	0.0191132	0.0276193	0.1802710	0.0552578	0.3757829	0.1628411	0.0768742	0	0.0831671	0.0079367
SGA	0.2376814	0.1499674	0.1487996	0.1949822	0.4012234	0.1399270	0.5850108	0.3380898	0.1554278	0.2923950	0	0.0916433
TRUSTB	0.3104417	0.1928891	0.2269379	0.2132358	0.6001300	0.3429058	0.7919243	0.5319105	0.2967008	0.4240781	0.2985568	0

Aggregated preference matrix for the year 2021

	ABC	AGB	Alssalam	BEA	BNA	BNPP	CNEP	CPA	Elbaraka	FRANSB	SGA	TRUSTB
ABC	0	0.0202533	0.0477643	0.0761103	0.1122482	0.0376330	0.1709623	0.1381537	0.0884382	0.0535624	0.0205359	0.0337225
AGB	0.2089926	0	0.0867220	0.0911015	0.1611110	0.1072414	0.3455783	0.1841812	0.1036525	0.2378435	0.0004201	0.0408268
Alssalam	0.1827011	0.0329195	0	0.0298798	0.1047990	0.0959979	0.2747263	0.1274295	0.0413970	0.2207807	0.0113722	0.0611446
BEA	0.2790137	0.1052656	0.0978464	0	0.1776347	0.1727714	0.3669037	0.1942920	0.0363864	0.3182716	0.0297540	0.0853928
BNA	0.1444131	0.0045365	0.0020270	0.0068962	0	0.0833234	0.2307109	0.0384890	0.0044521	0.1702957	0.0034445	0.0253717
BNPP	0.2563199	0.1371889	0.1797480	0.1885548	0.2698454	0	0.3495391	0.2876133	0.2014358	0.2818230	0.0377452	0.0801306
CNEP	0.0401100	0.0259867	0.0089372	0.0331481	0.0676938	0	0	0.0868650	0.0279539	0.0435756	0	0.0668135
CPA	0.1467651	0.0040533	0.0011041	0	0.0149356	0.0775378	0.2263287	0	0.0018272	0.1645102	0.0028239	0.0362554
Elbaraka	0.2770906	0.1035656	0.0951126	0.0221354	0.1609397	0.1714014	0.3474586	0.1818682	0	0.3028942	0.0132779	0.0945000
FRANSB	0.0156118	0.0111536	0.0478933	0.0774176	0.1001804	0.0251855	0.1364773	0.1179482	0.0762913	0	0.0115737	0.0446355
SGA	0.4153526	0.2064975	0.2712520	0.2216673	0.3660964	0.2138751	0.5256690	0.3890291	0.2194421	0.4443409	0	0.0923876
TRUSTB	0.6626054	0.4809704	0.5550907	0.5113723	0.6220898	0.4903267	0.8265488	0.6565270	0.5347305	0.7114690	0.3264539	0