



Multi-criteria Evaluating the Financial Resilience of
Iranian Commercial Banks: A Neutrosophic-SWARA-
MULTIMOORA Approach

<https://doi.org/10.22034/dmait.2024.199486>

Mahmoud Gharehgozlou¹, Sasan Sohrabi Pirkoohi², Sarfaraz Hashemkhani Zolfani^{3*}

1. Department of Industrial Engineering and Management Systems, Amirkabir University of Technology, Tehran, Iran
2. Department of Energy Engineering, Faculty of Mechanical and Energy Engineering, Shahid Beheshti University, Tehran, Iran
3. School of Engineering, Catholic University of the North, Coquimbo, Chile.
4. *Corresponding Author: sa.hashemkhani@gmail.com

ARTICLE INFO

ABSTRACT

Article history:

Received: 2024/05/15

Revised: 2024/06/16

Accepted: 2024/06/23

Published: 2024/08/23

Keywords:

Financial resilience, Commercial banks,
Covid-19 crisis, MCDM, Neutrosophic sets

The financial resilience of commercial banks during the COVID-19 crisis is paramount for sustaining financing to the real economy and preserving financial stability amidst unprecedented challenges. This study evaluates the financial resilience of Iranian commercial banks using a multi-criteria decision-making (MCDM) approach. We employ the stepwise weight assessment ratio analysis (SWARA) approach in a neutrosophic setting to determine the weights of criteria influencing financial resilience, integrating a variety of expert opinions. This is followed by the ranking of selected commercial banks using the multi-objective optimization on the basis of a ratio analysis plus the full multiplicative form (MULTIMOORA) approach for a comprehensive evaluation. The sample comprises nine banks listed on the Tehran Stock Exchange (TSE), assessed across seven key criteria: debt structure, capital adequacy structure, leverage ratio, asset structure, and profitability. The findings reveal Pasargad bank as the most resilient, while Day bank emerges as the least resilient during the COVID-19 crisis. These findings underscore which banks with lower capital adequacy ratios and profitability are particularly susceptible to the pandemic's impacts. Furthermore, this study underlines the critical need for bank management to prioritize strengthening base capital to enhance financial resilience. Implementing these strategic measures will be crucial for commercial banks to navigate the challenges posed by the COVID-19 pandemic effectively.

1. Introduction

The global spread of epidemic diseases has historically posed significant challenges to various aspects of society, including public health, economies, and social structures. The emergence of the COVID-19 pandemic has had a profound impact on jobs and economies worldwide, disrupting industries, supply chains, and financial markets. In Iran, the effects of the pandemic have been particularly pronounced, exacerbating the country's existing economic challenges. The COVID-19 pandemic has led to significant job losses in Iran, with more than 1 million people, out of a labor force of 27 million, losing their jobs in 2020. The economic turbulence caused by the COVID-19 pandemic has had varying effects on different segments of the population. By September 2021, it became evident that certain demographics in Iran were experiencing a

disproportionate impact. Notably, female employment witnessed a significant decline of 21% compared to pre-pandemic levels. In contrast, male employment experienced a comparatively smaller contraction of 2.1%. The substantial increase in inflation has had a severe impact on the lives of middle and low-income Iranians, as the prices of essential goods have risen by around 70-80% in the past year (Rosenberg & Nada, 2022). This has significantly affected their ability to sustain their livelihoods. In the face of these challenges, commercial banks have played a crucial role in mitigating the economic fallout. Banks have provided financial support, implemented relief measures, and adapted their operations to support businesses and individuals during these turbulent times. Ignoring the turmoil within the financial industry, particularly the banking industry, would inevitably lead to economic disruptions and instability. Maintaining the financial resilience of commercial banks is crucial during the COVID-19 pandemic, as it directly impacts the flow of financing to the real economy and the overall financial stability of the system.

In recent years, Iran's economy has encountered significant difficulties, which have been amplified by the severe impact of international sanctions and the COVID-19 pandemic. The sanctions, imposed in response to geopolitical tensions, have severely restricted Iran's access to global financial systems and oil markets, leading to a protracted economic crisis. This has manifested in high inflation, currency devaluation, and a significant decline in gross domestic product (GDP) growth, with the economy contracting by 6.8% in 2020 (Karimi & Turkamani, 2021). The COVID-19 pandemic has further compounded Iran's economic woes, leading to job losses, surging inflation, and a widening gap between household incomes and the cost of living. The combination of sanctions and pandemic-induced disruptions has resulted in a "lost decade" of negligible economic growth for Iran, with GDP growth averaging just 2.5% in 2021. In this challenging environment, the financial resilience of Iran's commercial banks has become paramount. These institutions have had to navigate a landscape of high non-performing loans (NPLs), liquidity constraints, and operational disruptions. The pandemic has exacerbated pre-existing weaknesses in the banking sector, with some banks struggling to maintain adequate capital buffers and liquidity ratios. Addressing these vulnerabilities and strengthening the overall resilience of the financial system will be crucial for Iran to weather the current economic storm and lay the foundation for sustainable growth in the post-pandemic era.

The COVID-19 pandemic has significantly disrupted the performance and stability of commercial banks in Iran, aligning with global trends. Recent research highlights a substantial decline in bank profitability and financial resilience attributed to the outbreak, posing complex challenges for the banking sector (Shabir et al., 2023). Iranian banks have been dealing with a significant increase in NPLs as businesses and individuals face difficulties in meeting their financial obligations due to the economic turmoil. The economic strains caused by the pandemic have put pressure on banks' solvency, as challenges in loan repayments and diminished capital reserves pose risks to their financial stability. In addition, Iranian banks have experienced significant withdrawals of deposits from both businesses and households, which have put additional strain on their liquidity positions. The consequences of the pandemic on different sectors have amplified credit risks for banks, posing a threat to the overall stability of the banking system and impeding future financial transactions. The effects of COVID-19 on the performance of banks in Iran have differed, depending on the country's financial infrastructure and institutional quality. Regions that were heavily affected by the virus have witnessed more significant declines in efficiency and profitability within their banking sectors. However, banks that have adopted diversification strategies have shown greater resilience, utilizing these strategies to mitigate the negative impacts of the pandemic. The exploration of criteria influencing the financial resilience of Iranian banks remains an underexplored topic in research studies.

This study aims to evaluate the financial resilience of selected commercial banks in Iran, employing a multi-criteria decision-making (MCDM) approach that incorporates the advantages of neutrosophic theory. The neutrosophic set allows for the effective handling of uncertainty and ambiguity inherent in expert judgments, which is particularly relevant given the unprecedented nature of the COVID-19 crisis (Smaransache et al., 2016). By utilizing the stepwise weight assessment ratio analysis (SWARA) approach within a neutrosophic setting; this research determines the weights of criteria influencing the financial resilience of Iranian banks. The study then ranks the selected banks using the multi-objective optimization on the basis of a ratio analysis plus the full multiplicative form (MULTIMOORA) approach to provide a comprehensive evaluation of their resilience during the pandemic. The findings reveal that Pasargad bank

emerges as the most resilient, while Day bank is identified as the least resilient in managing the shocks of the COVID-19 pandemic. This underscores the varying levels of credit exposure and risk tolerance across different industries, necessitating a nuanced approach to forecasting the adverse effects of the pandemic on the banking sector. By employing the neutrosophic-SWARA-MULTIMOORA approach, this study offers a robust and reliable assessment of the financial resilience of Iranian commercial banks, providing valuable insights for policymakers, regulators, and bank management to navigate the challenges posed by the ongoing crisis.

The remainder of this paper is organized into five distinct sections to provide a comprehensive examination of the topic. Section 2 offers an extensive review of the existing literature on financial resilience trends, synthesizing the key findings and insights from prior research in this domain. Section 3 outlines the specifics of the MCDM approaches employed in this study, detailing the methodological framework and the rationale behind the selection of these analytical techniques. The results derived from the application of these MCDM models are presented and discussed in Section 4, providing a detailed analysis of the financial resilience of the selected Iranian commercial banks. Finally, Section 5 concludes the paper by summarizing the key research outcomes and proposing potential avenues for future research, while acknowledging the constraints and limitations of the current study.

2. Literature review

The concept of financial resilience is interpreted diversely across various fields. According to Dahles et al. (Dahles & Susilowati, 2015), resilience in the context of business refers to the ability of businesses to withstand crises and adapt to adverse situations while maintaining their operations and pursuing growth opportunities. Similarly, according to the Basel committee's report (Bank for International Settlements, 2009), a bank's financial resilience refers to its ability to deliver critical operations despite disruptions. This capability allows banks to continue providing essential services even in the face of adverse events, such as economic downturns or operational disruptions.

After the 2008 global financial crisis, the financial intermediation process encountered significant challenges. These disruptions undermined the trust of depositors, resulting in widespread withdrawals and further deteriorating the already precarious fiscal state of the banks. In response to these challenges, the Basel committee formulated a set of proposals aimed at reinforcing the resilience of financial institutions. These initiatives encompassed a multifaceted approach to strengthening the stability of the banking system. They included strategies to improve the quality of capital held by banks, ensuring its capacity to absorb losses effectively. Additionally, there was a concerted effort to enhance risk management frameworks, particularly concerning credit exposures in instances of counterparty default. Measures such as implementing leverage ratios, establishing capital buffers, and prioritizing the adoption of expected loss models over incurred loss models were also recommended to enhance resilience. The overarching objective of these measures was to fortify banks as robust systems capable of enduring future stresses and maintaining financial stability. By bolstering the resilience of banks, the Basel committee aimed to mitigate the adverse impacts of potential future crises and safeguard the integrity of the global financial system (Bank for International Settlements, 2009).

Regarding the factors influencing banking system resilience, Hahn & Melecky (2013) contended that banks with diversified deposit bases tended to be more resilient during crises, advocating for broader financial inclusion in policymaking. Conversely, and Bakir (2013) argued that solely relying on capital adequacy-based regulations was insufficient due to the dynamic nature of risks. Another study by Guettafi & Laib (2016) introduced a novel approach by constructing a composite Financial Stability Index (FSI) for Algeria's financial system. Incorporating IMF's Financial Soundness Indicators (FSIs), Financial Resilience Indicators (FRIs), and Macroeconomic Resilience Indicators (MRIs), the research explores the relationship between these indexes and their impact on financial stability. Findings suggest that while FSIs and FRIs reflect stability, MRIs contribute to instability, with FRIs particularly offering a more nuanced reflection of financial stability compared to FSIs, which are largely regulated.

The COVID-19 pandemic presents a considerable threat of economic decline as it has led to increased unemployment rates, resulting in decreased levels of savings and investment Bank (2020). This situation arises from the widespread loss of jobs, which not only impacts individuals' ability to save, but also reduces their capacity to invest in various economic activities. The ripple effects of unemployment extend beyond individuals to businesses, which may face lower consumer demand and revenue, further exacerbating the economic downturn. Moreover, the pandemic has disrupted global supply chains and trade, adding additional strains to economies already grappling with the consequences of reduced consumer spending and investment. The uncertainties surrounding the duration and severity of the pandemic contribute to heightened market volatility and investor apprehension, potentially dampening investment sentiments.

This situation may trigger widespread savings withdrawals, increased default rates, diminished lending and investment, reduced income from loan interest, and heightened bankruptcy risks (World Bank 2020). Developing countries, grappling with weak institutional governance, underdeveloped capital markets, and bureaucratic hurdles in policy formulation, face challenges in swiftly recovering from pandemic-induced shocks (Wilson, 2020). Aldasoro et al. (2020) suggest that banks with robust capital bases and high profitability are better equipped to weather pandemics. Nguyen et al. (2020) proposed a comprehensive Decision Support Model to evaluate the financial performance of retail companies on the Vietnam Stock Exchange, considering valuation, profitability, growth, liquidity, efficiency, and leverage ratios. Data from 12 companies spanning 2019-2020 was analyzed, with weights of 18 financial ratios determined using the standard deviation approach. Grey Relational Analysis ranked companies quarterly, highlighting leverage ratios as the most impactful. Demir (2022) proposed a multi-criteria model using logarithm methodology of additive weights (LMAW) and double normalization-based multiple aggregation (DNMA) approaches to assess deposit banks' performance during COVID-19. Performance indicators are weighted using LMAW and then evaluated with DNMA. Results suggest a severe impact on deposit banking due to COVID-19, indicating inefficiency in managing pandemic-related risks. Findings aid bank management, investors, and regulators in decision-making for banking stability. Sensitivity analyzes confirm model reliability, showing consistent outcomes. Also, Nguyen et al. (2022) introduced a hybrid MCDM approach for evaluating Vietnamese banks, utilizing criteria importance through intercriteria correlation (CRITIC), decision-making trial and evaluation laboratory (DEMATEL), and technique for order of preference by similarity to ideal solution (TOPSIS) approaches. Findings reveal COVID-19's significant impact on asset quality, liquidity, and growth, underscoring the need for enhanced risk management and digital transformation in banking.

This study aims to assess the robustness of Iran's financial sector by examining the viability of banks' credit portfolios, particularly those susceptible to adverse impacts resulting from the COVID-19 pandemic. To accomplish this, we will employ an MCDM approach that encompasses a thorough analysis of various factors contributing to the resilience of banks' credit portfolios.

3. Methodology

To determine the ranking of commercial banks in terms of financial resilience during the Covid-19 pandemic, a MCDM approach was employed. This approach involved various experts initially evaluating the criteria that impact financial resilience. After aggregating the diverse opinions, the weight of the different criteria was determined. Finally, by applying the weight of the criteria and evaluating each alternative based on the different criteria, the ranking of the financial resilience of the alternatives was obtained. Figure 1 provides a detailed illustration of the proposed approach.

3.1. Data gathering

This section is structured into three distinct sub-sections, encompassing the identification of alternatives, the determination of criteria, and the incorporation of decision-makers.

3.1.1. Alternatives (A)

In the context of this study, nine commercial banks listed on the Tehran Stock Exchange (TSE) have been selected as alternatives. This selection was made based on the consistency in the reporting structure of their financial statements within their annual reports. Unfortunately, the remaining commercial banks listed on the TSE could not be included due to discrepancies in their financial reporting structure. Table 1 provides a brief description of the selected commercial banks.

Table 1. Banks selected for financial resilience ranking.

NO.	Bank name	Symbol
1	Tejarat Bank	BTEJ
2	Saderat Bank	BSDR
3	Sina Bank	VSIN
4	Pasargad Bank	BPAS
5	Eghtesad Novin Bank	NOVN
6	Post Bank	BPST
7	City Bank	BSHP
8	Parsian Bank	BPAR
9	Day Bank	BDYZ

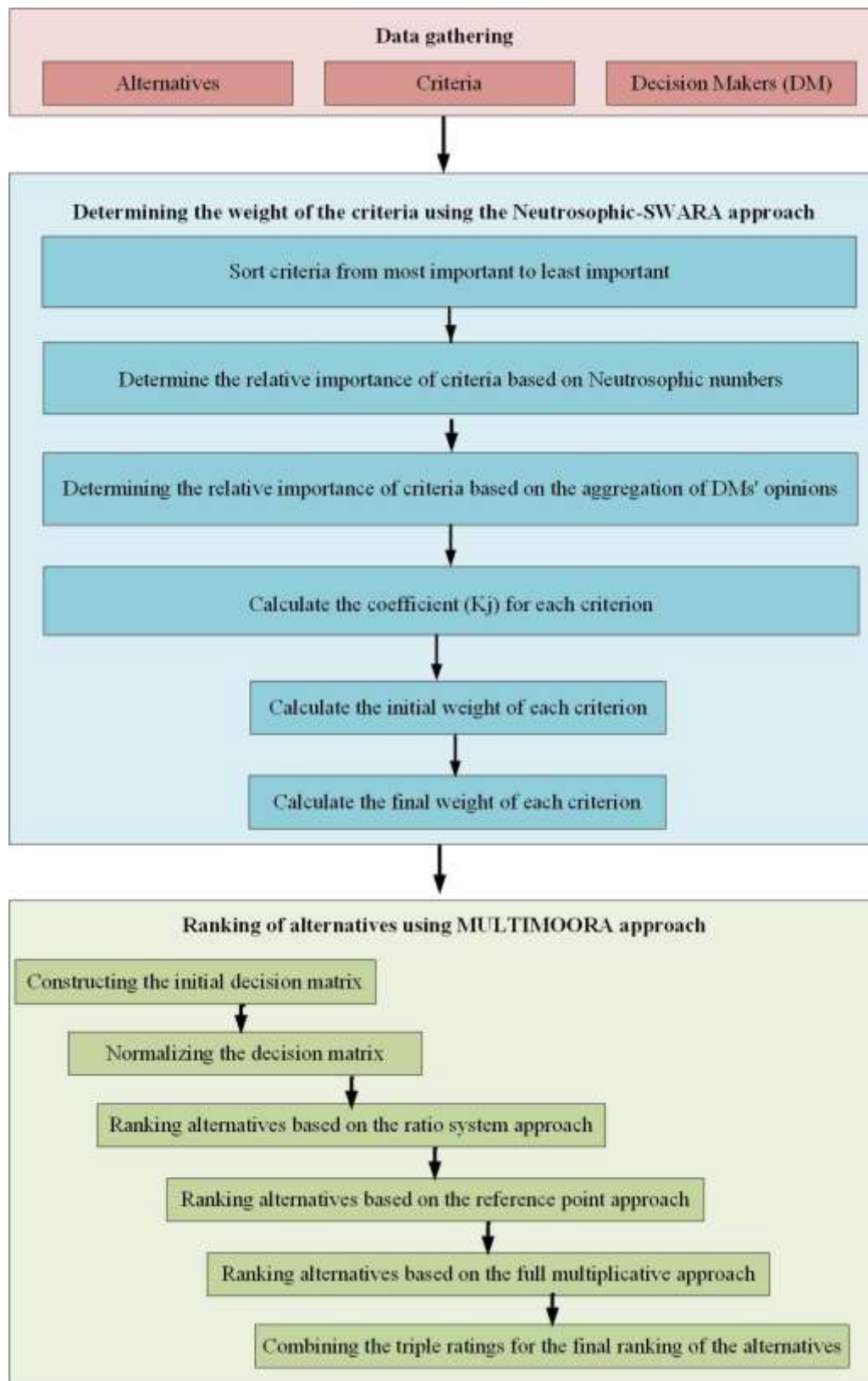


Figure 1. Framework of the proposed approach.

3.1.2. Criteria (C)

Given that assessing financial resilience hinges on identifying suitable evaluation criteria, a specific set of criteria outlined in existing literature has been selected. This study utilizes five criteria, detailed in Table 2, to

evaluate and rank the financial resilience of commercial banks. The selection of these criteria is crucial for ensuring a comprehensive and systematic evaluation of financial resilience in the context of commercial banks. By leveraging established criteria from the literature, this research aims to provide a robust framework for assessing and comparing the financial resilience of banks facing challenges such as the COVID-19 pandemic. The utilization of these five criteria serves as a foundation for a structured and objective evaluation process, enabling a nuanced understanding of the financial resilience of commercial banks.

Table 2. Criteria affecting the financial resilience of commercial banks

NO.	Criteria	Description
C ₁	Debt structure	The main objective of this criterion is to assess the main debt elements found in banks, which mainly comprise deposits from different sectors. These encompass deposits from savings accounts, investments in different areas of the economy, debts owed by the bank to other financial institutions, as well as short-term and long-term deposits made by other banks. By analyzing these elements together, we can gain insights into the debt composition of a bank as it appears on its balance sheet. To gauge the bank's debt composition, we employ the ratio of total debt to total assets.
C ₂	Capital adequacy structure	The capital adequacy ratio (CAR) is a crucial measure determined by dividing the bank's capital structure by the total amount of assets adjusted for their associated risk. By ensuring a sufficient buffer of capital, banks can effectively handle the risks involved in their operations and safeguard depositors from incurring losses. Each bank establishes its CAR by considering the rate recommended by the central bank of their respective country.
C ₃	Leverage Ratio	The liquidity-to-total-assets ratio is a key criterion that represents the proportion of a bank's liquid assets relative to its total assets. This ratio has been empirically recognized as a significant factor influencing the distinction between the default and non-default of financial institutions. To evaluate the bank's debt structure, the liquidity-to-total-assets ratio is used.
C ₄	Asset structure	Cash, liquid assets, and credit facilities are the key elements analyzed in this criterion. Together, they provide a snapshot of the assets held by a bank, as detailed in its balance sheet. Assessing the bank's asset structure involves using the fixed assets to current assets' ratio as a measure.
C ₅	Profitability	Profitability plays a crucial role in enhancing financial resilience within banks. A strong level of profitability contributes significantly to financial resilience by providing a solid financial foundation that can withstand economic adversities. The net profit and loss presented in the financial statements have been used to quantify this criterion.

3.1.3. Decision Makers (DM)

In this study, a panel of five experts with a minimum of ten years of professional experience in the financial and banking sectors was constituted to ascertain the relative significance of various criteria impacting the financial resilience of banking institutions. Their extensive backgrounds and expertise in the field have contributed to the robustness and validity of the study's findings, providing valuable insights into the weight of the criteria influencing the financial resilience of banks.

In the assessment of criteria, it is essential to account for the unique weighting assigned to each DM's judgment to ascertain the overall average final weight accurately. Given the variability in DMs' expertise and experience, we posit distinct comprehensive weights for their viewpoints to influence the total average final weight of criteria significantly. The relative importance weights of DMs are represented through a linguistic

variable, as illustrated in Table 3, along with its corresponding single value neutrosophic number (SVNN) values. Equation 1 is used to determine the crisp weight of each DM (V_k).

Table 3. Linguistic variable and its corresponding SVNN for relative importance weight of DM (Biswas et al., 2016).

Linguistic variable	SVNN $\langle T, I, F \rangle$
Very important	$\langle 0.90, 0.10, 0.10 \rangle$
Important	$\langle 0.80, 0.20, 0.15 \rangle$
Medium	$\langle 0.50, 0.40, 0.45 \rangle$
Unimportant	$\langle 0.35, 0.60, 0.70 \rangle$
Very unimportant	$\langle 0.10, 0.80, 0.90 \rangle$

$$V_k = \frac{T_k + I_k \times (T_k / (T_k + F_k))}{\sum_{k=1}^K T_k + I_k \times (T_k / (T_k + F_k))} \quad (1)$$

where K is the total number of DMs and $V_k \geq 0, \sum_{k=1}^K V_k = 1$.

3.2. Determining the weight of the criteria using the neutrosophic-SWARA approach

In this study, the neutrosophic-SWARA approach undergoes a structured process comprising five sequential steps, is employed for criterion weighting. Initially, each DM goes through the first two steps to determine the relative importance of criteria using linguistic variables. Following this, the SVNNs allocated by each DM are aggregated according to the relative importance assigned to each DM (V_k), for subsequent utilization in steps three through five.

Step 1. Sort the criteria from most important to least important.

Each of the DM should sort the criteria in Table 2 in order of importance, from most to least important.

Step 2. Determine the relative importance of criteria based on neutrosophic numbers

The relative importance of the criteria (S'_j) is ascertained through the utilization of linguistic variables and its corresponding SVNN representations, as depicted in Table 4. Specifically, the "Very High Influence" linguistic variable is assigned to the most significant criterion, while the remaining criteria are compared to their higher-ranked counterparts, and appropriate linguistic variables are designated accordingly.

Table 4. Linguistic variable and its corresponding SVNN for relative importance weight of criteria.

Linguistic variable	$S'_j: \langle T, I, F \rangle$
No Influence	$\langle 0.00, 0.00, 0.00 \rangle$
Low Influence	$\langle 0.20, 0.70, 0.80 \rangle$
Medium Low Influence	$\langle 0.35, 0.60, 0.60 \rangle$
Medium Influence	$\langle 0.50, 0.40, 0.45 \rangle$
Medium High Influence	$\langle 0.65, 0.30, 0.25 \rangle$
High Influence	$\langle 0.80, 0.20, 0.15 \rangle$
Very High Influence	$\langle 1.00, 0.00, 0.00 \rangle$

Step 3. Determining the relative importance of criteria based on the aggregation of DMs' opinions

The collective viewpoints of all DMs need to be consolidated to form a vector representing the relative importance within the neutrosophic set of criteria (S_j''). The aggregation of SVNN ratings is achieved through the utilization of the single-valued neutrosophic set weighted aggregation (SVNSWA) operator, as denoted by Equation 2. Then the crisp number (S_j) corresponding to each S_j'' is obtained through Equation 3.

$$S_j'' = \langle 1 - \prod_{k=1}^K (1 - T_k)^{V_k}, \prod_{k=1}^K (I_k)^{V_k}, \prod_{k=1}^K (F_k)^{V_k} \rangle \quad (2)$$

$$S_j = \frac{(3 + T - 2I - F)}{4} \quad (3)$$

Step 4. Calculate the coefficient (K_j) for each criterion

During this stage, the K_j coefficient is established for each criterion in accordance with Equation 4. The K_j coefficient is assigned a value of 1 for the most important criterion, with subsequent criteria incrementing the value of S_j by 1.

$$K_j = \begin{cases} 1 & j = 1 \\ 1 + S_j & j > 1 \end{cases} \quad (4)$$

Step 5. Calculate the initial weight of each criterion (q_j)

The initial weight for each criterion can be computed utilizing Equation 5. The value is set to 1 automatically for the first row, representing the criterion with the highest score. For the following criteria, the q_j value of the preceding criterion is divided by the K_j value of the criterion under analysis in the previous step.

$$q_j = \begin{cases} 1 & j = 1 \\ \frac{q_{j-1}}{K_j} & j > 1 \end{cases} \quad (5)$$

Step 6. Calculate the final weight of each criterion (W_j)

The final weight of each criterion can be calculated by dividing the initial weight obtained in the preceding step by the sum of all initial weights, as specified in Equation 6.

$$W_j = \frac{q_j}{\sum_{j=1}^n q_j} \quad (6)$$

3.3. Ranking of alternatives using MULTIMOORA approach

The present study employs the MCDM approach to analyze the financial resilience of banks in the face of potential risks resulting from the unforeseen outbreak of the COVID-19. The application of the MCDM approach provides a structured framework for decision-making, enabling a systematic evaluation and ranking of banks based on their financial resilience to the crisis posed by the COVID-19 pandemic. This framework assists in identifying the strengths and weaknesses of each bank, empowering policymakers and stakeholders to make informed decisions and implement appropriate measures to ensure the stability and sustainability of the banking sector during times of crisis.

This study incorporates the utilization of the MULTIMOORA approach. By employing the MULTIMOORA approach, a comprehensive evaluation of the banks' performance and financial resilience has been conducted. The MULTIMOORA approach enables the consideration of multiple objectives and criteria, allowing for a more holistic evaluation of the banks' capabilities in navigating the challenges brought forth by the COVID-19 pandemic. This approach incorporates a multiplicative exponential weighting function to assign appropriate weights to the criteria, thereby enhancing the accuracy and robustness of the analysis.

The main characteristic of the MULTIMOORA approach is its utilization of a multiplicative exponential weighting function. This function introduces non-linearity in the evaluation process and allows DMs to capture their preferences and priorities more accurately. By incorporating the multiplicative exponential weighting function, this approach enables DMs to assign different levels of importance to each criterion. This flexibility allows for a more nuanced and customized evaluation of alternatives, as it accommodates varying degrees of preference for different criteria. In the MULTIMOORA approach, the steps followed are similar to the MOORA approach, but with an additional step.

Step 1: Constructing the initial decision matrix (X)

In this step, the alternatives and criteria are identified in a matrix format (X). The matrix has the alternatives listed as rows and the criteria listed as columns.

$$X = \begin{bmatrix} c_1 & \cdots & c_j & \cdots & c_n \\ x_{11} & \cdots & x_{1j} & \cdots & x_{1n} \\ \vdots & & \vdots & & \vdots \\ x_{i1} & \cdots & x_{ij} & \cdots & x_{in} \\ \vdots & & \vdots & & \vdots \\ x_{m1} & \cdots & x_{mj} & \cdots & x_{mn} \end{bmatrix} \begin{matrix} A_1 \\ \vdots \\ A_i \\ \vdots \\ A_m \end{matrix}$$

Step 2: Normalizing the decision matrix (x^*)

After constructing the decision matrix, the next step is to normalize the matrix. This normalization process is carried out by dividing each value in the matrix by the sum of its respective column. The purpose of normalization is to ensure that all criteria are evaluated on a comparable scale. Equation 7 is used for normalization in this approach.

$$x_{ij}^* = \frac{x_{ij}}{\sqrt{\sum_{i=1}^m x_{ij}^2}} \quad (7)$$

Step 3: Ranking alternatives based on the ratio system approach (y_i)

The MULTIMOORA model incorporates the ratio system approach as one of the ranking techniques employed to evaluate the alternatives. This approach takes into account the weights (w_j) assigned to the criteria, which are calculated using the neutrosophic-SWARA approach. The ratio system approach considers both positive and negative criteria, where positive criteria are those for which higher values are desirable, and negative criteria are those for which lower values are preferable. The ranking based on the ratio system approach is determined using Equation 8.

$$y_i = \sum_{j=1}^g w_j x_{ij}^* - \sum_{j=g+1}^n w_j \cdot x_{ij}^* (j = 1, 2, \dots, n) \quad (8)$$

In this equation, w_j represents the weight assigned to each criterion with neutrosophic-SWARA, and x_{ij}^* represents the normalized performance value of the i -th alternative on the j -th criterion. The positive criteria (from 1 to g) are multiplied by their respective weights and summed up, while the negative criteria (from $g+1$ to n) are multiplied by their respective weights and summed up with a negative sign. This calculation yields a rank for each alternative. By using the ratio system approach, the MULTIMOORA approach takes into account both the performance values and the weights assigned to the criteria, providing a comprehensive ranking of the alternatives. The best alternative according to the ratio system approach is the one with the maximum utility, denoted as y_i . The ranking of the alternatives using this approach is determined in descending order, following Equation 9, where the alternatives are arranged from highest to lowest based on their utility values.

$$R_{RS} = \{A_{i|max y_i} > \dots > A_{i|min y_i}\} \quad (9)$$

Step 4: Ranking alternatives based on the reference point approach

In this stage, the alternatives are assessed according to the reference point approach. It is necessary to establish a reference point for each criterion during this process. This approach is based on the Tchebycheff min-max metric (Brauers & Zavadskas, 2006). In the reference point approach, the utility is determined by defining the maximal objective reference point (MORP) vector. The MORP vector represents a set of reference points that define the maximum or optimal values for each criterion. The MORP vector is used as a benchmark to evaluate the performance of alternatives. It consists of the highest achievable values for positive criteria and the lowest achievable values for negative criteria. The MORP vector establishes the upper bounds for positive criteria and lower bounds for negative criteria, against which the performance of alternatives is compared. The MORP vector is defined in Equation 10.

$$r_j = \{max x_{ij}^*, j \leq g; min x_{ij}^*, j > g\} \quad (10)$$

Equation 11 calculates the distance between the MORP vector members and the alternative rating by taking into account their weighted values.

$$d_{ij} = |w_j r_j - w_j x_{ij}^*| \quad (11)$$

The utility in the reference point approach is achieved by maximizing the distance, as described in Equation 12.

$$z_i = max_j d_{ij} \quad (12)$$

Using the reference point approach, the best alternative has the minimum utility z_i and is ranked in ascending order as Equation 13.

$$R_{RPA} = \{A_{i|min z_i} > \dots > A_{i|max z_i}\} \quad (13)$$

Step 5: Ranking alternatives based on the full multiplicative approach

To determine the utility in the full multiplicative approach, an incompletely-compensatory model, the weighted normalized ratings for beneficial criteria are multiplied together and divided by the product of the weighted normalized ratings for non-beneficial criteria. The best alternative has the highest utility value, denoted as u_i in Equation 14.

$$u_i = \prod_{j=1}^g (x_{ij}^*)^{w_j} / \prod_{j=g+1}^n (x_{ij}^*)^{w_j} \quad (14)$$

The ranking of the alternatives using this approach is determined in descending order, meaning that the alternatives are ranked from highest to lowest based on their utility values, as specified in Equation 15.

$$R_{FMF} = \{A_{i|max u_i} > \dots > A_{i|min u_i}\} \quad (15)$$

Step 6: Combining the triple ratings for the final ranking of the alternatives

Subsequent to deriving the subordinate rankings, it becomes necessary to amalgamate these rankings to arrive at the ultimate ranking of the alternatives. For this purpose, this study employs the dominance theory approach, which relies on various principles such as dominance (both absolute and partial), equality (both absolute and partial, as well as equality based on circular reasoning), and transitivity. Dominance theory encompasses the concept of dominance, which involves the comparison of alternatives to determine if one alternative clearly dominates another (absolute dominance) or if there is a partial dominance relationship between them. Additionally, the theory considers equality, which encompasses cases of absolute equality, partial equality, and equality based on circular reasoning. Lastly, the principle of transitivity is applied, ensuring that if alternative A dominates alternative B, and alternative B dominates alternative C, then alternative A will also dominate alternative C. These principles are guiding the comparison and evaluation of alternatives to establish their relative rankings.

4. Empirical results

This study examines the financial resilience of a sample of nine prominent commercial banks listed on the TSE during the COVID-19 pandemic in Iran. The data collection period spans from 2019 to 2021, encompassing the onset and initial stages of the public health crisis in the country. The selected timeframe aligns with the emergence of the first reported COVID-19 case in Iran and the subsequent period until the official cessation of virus-related fatalities within the nation. By focusing on this critical period, the research aims to provide a comprehensive assessment of how the pandemic has impacted the financial performance and resilience of the Iranian banking sector. The sample comprises nine leading commercial banks that play a significant role in the country's financial system. These institutions were chosen based on their prominence and systemic importance within the Iranian banking landscape. The financial data, including balance sheets, income statements, and other relevant metrics, were meticulously gathered from the audited reports of the selected banks for the three-year period under investigation.

This study leverages the expertise and insights of a panel of five professionals with extensive experience in the Iranian banking sector to weigh the criteria affecting banks' financial resilience. The selected experts are employed across various commercial banks and possess in-depth knowledge and familiarity with the operational dynamics and challenges facing the industry. Table 6 provides detailed information on the educational backgrounds and banking tenures of the expert participants, highlighting their qualifications and the breadth of their industry experience. To incorporate the expert opinions effectively, the researchers utilized a neutrosophic-based approach to assess the relative importance and weighting of each contributor. Specifically, the experts were evaluated and ranked based on their level of expertise, with the most experienced and knowledgeable individual designated as the most important source of input. This process of assigning weights to the expert opinions within the neutrosophic environment allows for the robust handling of the inherent uncertainty and ambiguity associated with subjective judgments, particularly in the context of the unprecedented COVID-19 crisis. The findings reveal that expert 1 holds the highest weighting, reflecting their extensive expertise and credibility within the banking sector. In contrast, expert 3 is accorded the lowest relative importance, owing to their comparatively less extensive experience and domain

knowledge. The incorporation of diverse expert perspectives, each weighted according to their level of expertise, is a key strength of the study's methodological approach.

Table 5: Experts' information incorporated in the study.

Experts	Banking tenures (Year)	Degree of education	Importance	Weight of opinion
1	12	Master	Important	0.252262
2	20	PH.D.	Very important	0.257883
3	7	Master	Medium	0.185084
4	2	Bachelor	Very unimportant	0.046888
5	25	PH.D.	Very important	0.257883

Figure 2 illustrates the debt structure of selected banks from 2019 to 2021, with Day and City banks exhibiting the highest levels of indebtedness within the sample. A detailed analysis reveals that Pasargad bank maintains a relatively stable debt structure across the three-year time period, indicating a consistent approach to managing debt obligations. The impact of debt structure on financial resilience is significant, as high levels of debt can increase financial vulnerability during economic downturns, limiting a bank's ability to absorb shocks and maintain liquidity. Banks with excessive debt may face challenges in meeting repayment obligations, especially in times of economic stress, potentially leading to solvency issues and reduced financial stability. Therefore, a prudent debt management strategy, characterized by a balanced and sustainable debt structure, is essential for enhancing the financial resilience of commercial banks and ensuring their long-term viability in the face of external shocks and uncertainties.

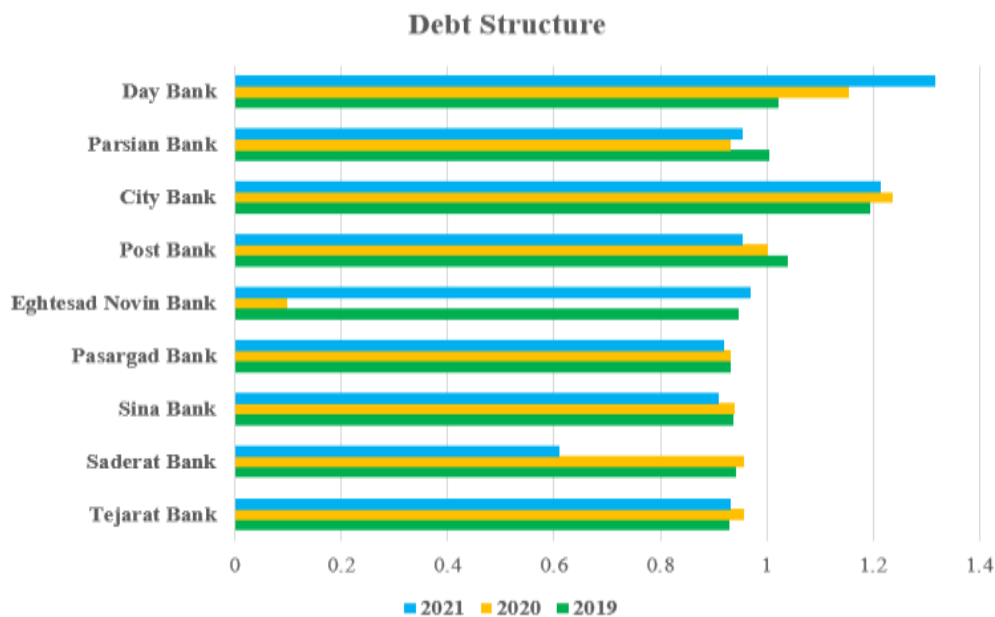


Figure 2. Debt structure status of selected banks during the Covid-19 pandemic

The capital adequacy structure is a key regulatory requirement that ensures banks hold sufficient capital to withstand unexpected losses and maintain financial stability. Banks with higher capital adequacy ratios are better equipped to navigate economic downturns, as they possess a larger buffer to absorb loan defaults, asset devaluations, and other adverse impacts. Conversely, institutions with inadequate capital levels are more susceptible to insolvency, liquidity crises, and the inability to extend credit to businesses and households, further exacerbating economic disruptions. As illustrated in Figure 3, the selected banks exhibit varying levels of capital adequacy across the 2019-2021 time period. The data reveals that Day and City banks maintain the lowest capital adequacy structure within the sample, indicating a heightened vulnerability to external shocks and potential solvency issues. In contrast, Pasargad and Sina banks

demonstrate the strongest capital positions, suggesting a more robust capacity to absorb losses and continue supporting the real economy during the crisis.

The findings from this study underscore the critical importance of maintaining strong capital positions for Iranian commercial banks to enhance their financial resilience during the COVID-19 pandemic. Banks with weaker capital adequacy, such as Day and City banks, face heightened risks of financial distress and may require targeted regulatory interventions or recapitalization efforts to bolster their resilience. Conversely, the robust capital positions of Pasargad and Sina banks enable them to better withstand the pandemic's shocks and continue fulfilling their role as financial intermediaries, supporting the broader economic recovery. By prioritizing the enhancement of capital adequacy structure, Iranian commercial banks can strengthen their capacity to absorb losses, sustain lending activities, and contribute to the overall stability of the financial system amidst the ongoing crisis.

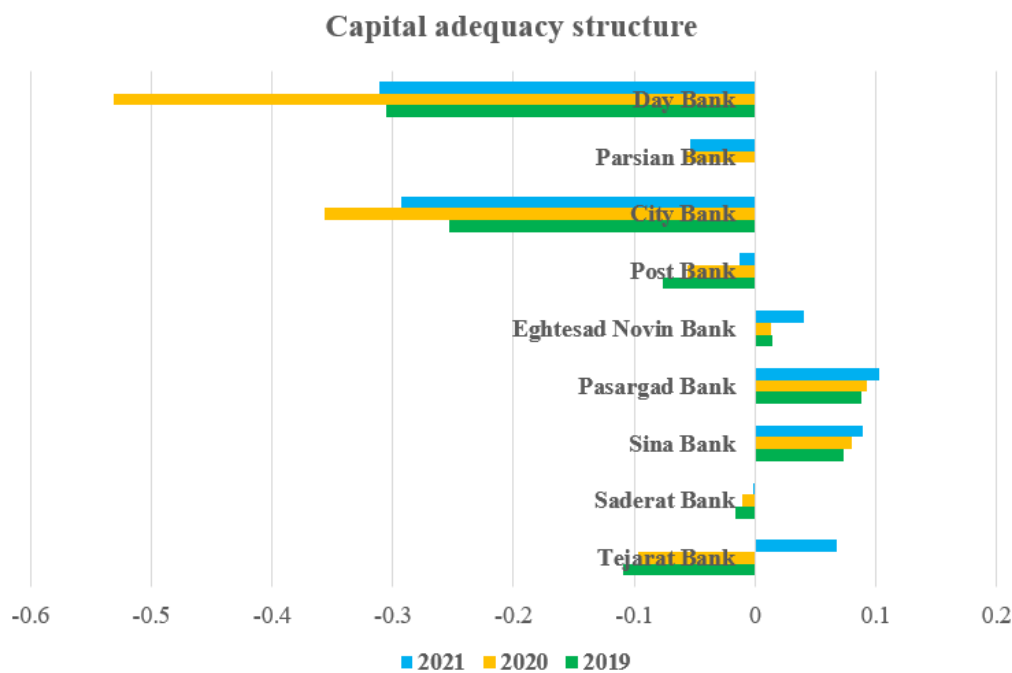


Figure 3. Capital adequacy structure status of selected banks during the Covid-19 pandemic

The analysis of leverage ratios among selected banks from 2019 to 2021, as depicted in Figure 4, reveals distinct patterns. Notably, Day and City banks exhibit the least favorable leverage ratios among the selected banks, while Pasargad and Sina banks demonstrate the most favorable leverage ratios. This disparity underscores the critical role of leverage ratio in determining financial resilience within the banking sector. High leverage ratio, as observed in Day and City banks, can amplify risks and vulnerabilities, potentially compromising financial resilience during economic downturns or periods of heightened market stress. Conversely, banks like Pasargad and Sina banks, with more favorable leverage ratios, are better positioned to withstand adverse market conditions and maintain financial robustness.

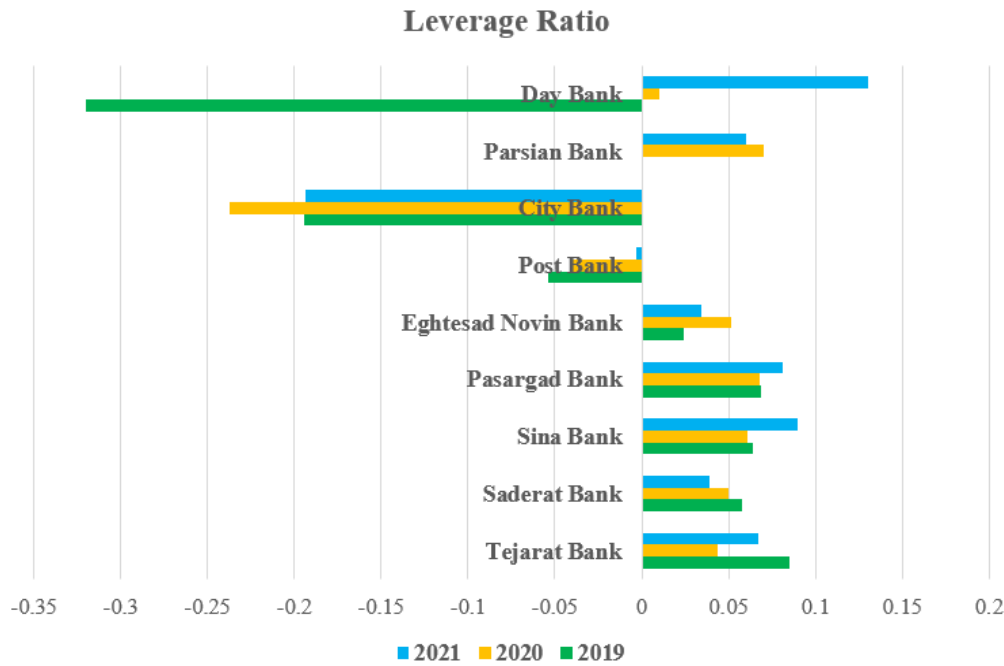


Figure 4. Leverage ratio status of selected banks during the Covid-19 pandemic

The analysis of asset structure among selected banks from 2019 to 2021, as illustrated in Figure 5, reveals distinctive patterns. Notably, Pasargad and Parsian banks exhibit the least favorable asset structures among the selected banks, while Day bank showcases the most favorable asset structure.

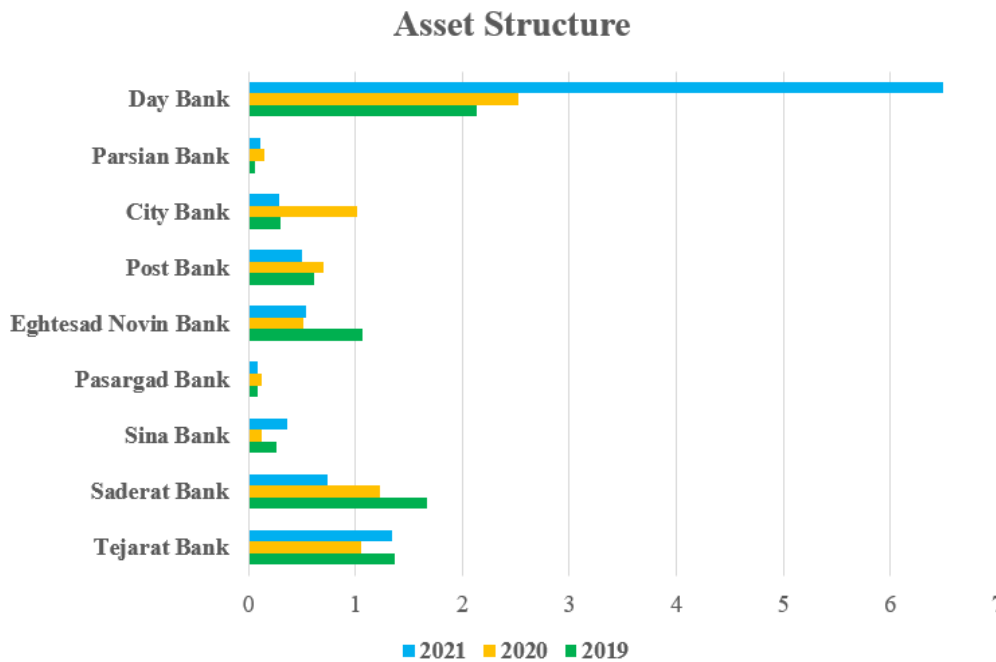


Figure 5. Asset structure status of selected banks during the Covid-19 pandemic

Figure 6 illustrates the profitability levels of selected banks from 2019 to 2021, revealing significant variations in financial performance across the sample. The City bank emerges with the lowest profitability among the selected banks, indicating potential challenges in generating sustainable earnings amidst economic uncertainties. Conversely, Eghtesad Novin and Pasargad banks stand out as the most profitable banks, reflecting their ability to maintain robust financial performance and navigate the challenges posed by the pandemic effectively. High profitability levels are indicative of a bank's capacity to generate sufficient income to cover operating expenses, loan losses, and capital requirements, thereby enhancing its resilience

to external shocks and economic disruptions. Banks with strong profitability are better positioned to withstand adverse market conditions, sustain lending activities, and support the real economy during times of crisis.

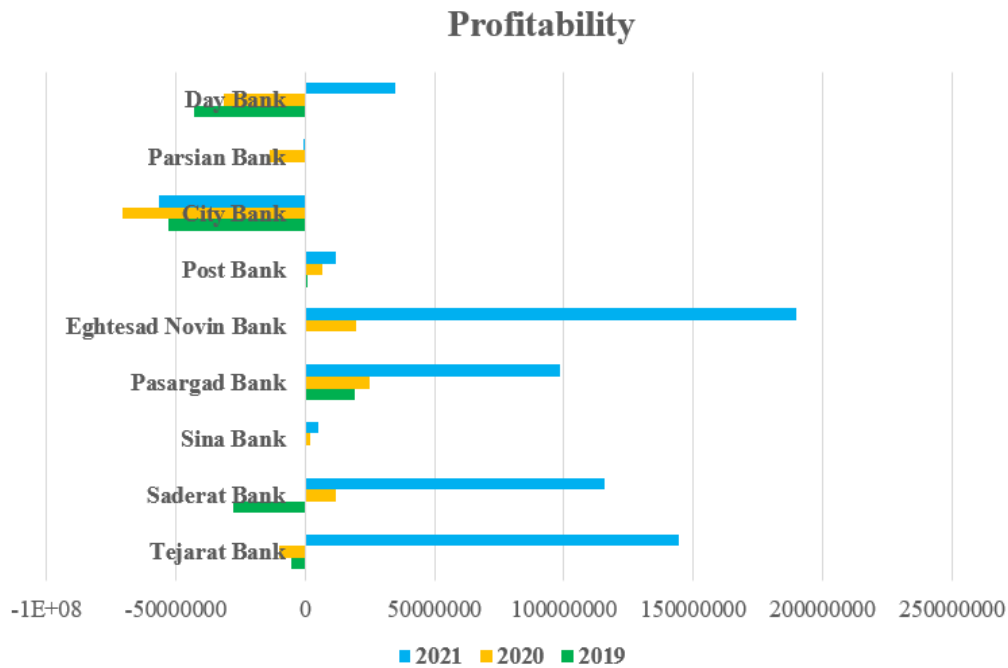


Figure 6. Profitability status of selected banks during the Covid-19 pandemic

In the examination of various criteria impacting the financial resilience of banks, as evidenced in Figures 2 to 6, a nuanced understanding emerges regarding the differential effects of these criteria. Through the integration of expert opinions within the framework of the SWARA approach, and mindful of the inherent uncertainties inherent in expert assessments, a comprehensive ranking of criteria has been established utilizing neutrosophic sets. Figure 7 elucidates the individual contributions of each criterion towards delineating the financial resilience of banks. Notably, the capital adequacy structure emerges as the paramount criterion, underscoring its pivotal role in bolstering financial resilience, while leverage ratio and asset structure are identified as comparatively less influential criteria.

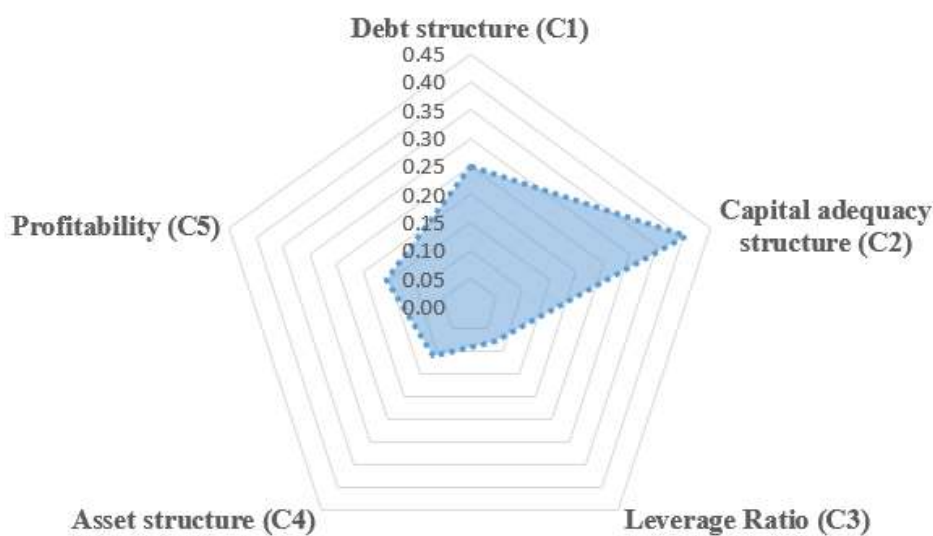


Figure 7. Ranking of criteria affecting the financial resilience of commercial banks

The evaluation of banks' financial resilience through a MULTIMOORA approach, as depicted in Figure 8, provides valuable insights into the performance and financial resilience of Iranian commercial banks during

the turbulent years of 2019, 2020, and 2021. The ranking of banks based on the ratio system, reference point, and complete multiplication approaches reveals nuanced patterns in financial resilience across the industry. Notably, Day and City banks consistently exhibit weaker financial resilience in most assessment approaches, indicating vulnerabilities that require strategic interventions to enhance their resilience. Conversely, Tejarat bank emerges as a standout performer, showcasing a notable improvement in financial resilience in 2021, underscoring the institution's adaptive capacity and strategic resilience-building efforts. Furthermore, Pasargad bank consistently demonstrates the highest level of financial resilience across multiple approaches throughout the three-year time period, highlighting the bank's robust risk management practices and financial resilience.

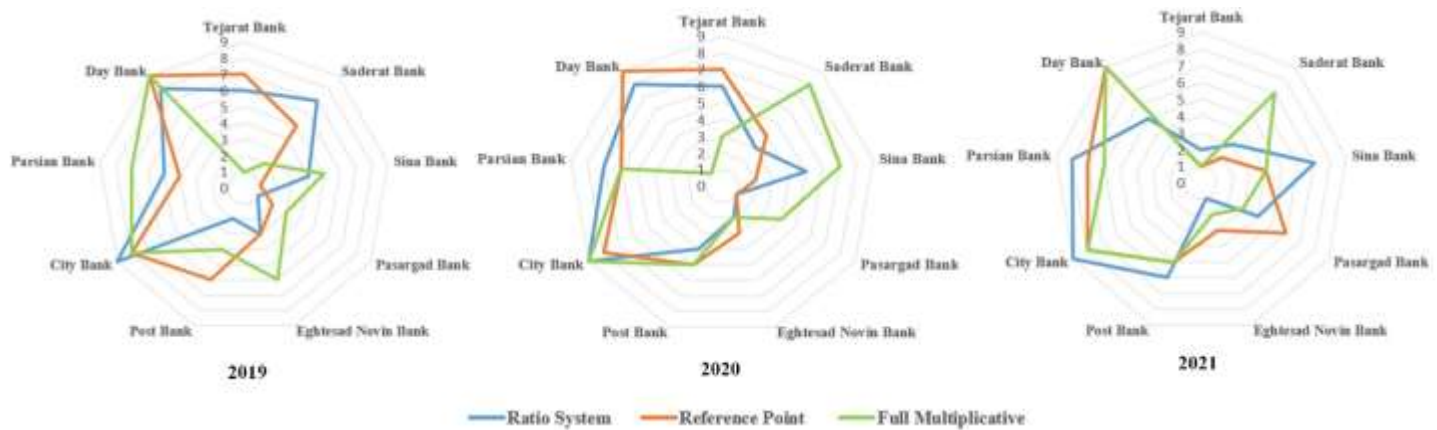


Figure 8. Ranking of different banks based on the ratio system, reference point and full multiplier approaches

The comprehensive evaluation of the financial resilience of Iranian commercial banks during the COVID-19 pandemic, as depicted in Figure 9, provides a nuanced understanding of the banking industry's performance and resilience. The application of the MULTIMOORA approach, offers a holistic assessment of the selected banks' resilience across a range of critical financial criteria. The findings reveal that Pasargad bank emerges as the most resilient bank within the sample, showcasing its ability to navigate the unprecedented challenges posed by the COVID-19 crisis. This superior performance underscores Pasargad bank's prudent risk management practices, strong capital adequacy, and effective liquidity management, which have enabled the bank to withstand the pandemic's shocks and continue supporting the real economy. In contrast, Day bank is identified as the least resilient among the selected commercial banks, indicating heightened vulnerabilities and a diminished capacity to absorb the adverse impacts of the pandemic. The lower ranking of Day bank suggests that the institution may be grappling with a combination of factors, such as weaker capital positions, liquidity constraints, and elevated non-performing loans, which have undermined its financial resilience during the crisis. The divergent performance of Pasargad and Day banks underscores the heterogeneity in the financial resilience of Iranian commercial banks amidst the COVID-19 pandemic. This finding emphasizes the need for a nuanced, bank-specific approach to assessing and addressing the challenges faced by the industry, as a one-size-fits-all solution may prove ineffective in addressing the unique circumstances and risk profiles of individual institutions.

The MULTIMOORA-based ranking provides a robust and reliable assessment of the financial resilience of the selected Iranian commercial banks, offering valuable insights for policymakers, regulators, and bank management. These findings can inform targeted interventions, tailored regulatory measures, and strategic decision-making to enhance the overall stability and resilience of the Iranian banking sector in the face of the ongoing pandemic and future economic shocks. By prioritizing the strengthening of capital adequacy, liquidity management, asset quality, and profitability, Iranian commercial banks can bolster their capacity to withstand the adverse impacts of the COVID-19 crisis and continue fulfilling their crucial role as financial intermediaries, supporting the broader economic recovery and sustainable growth.

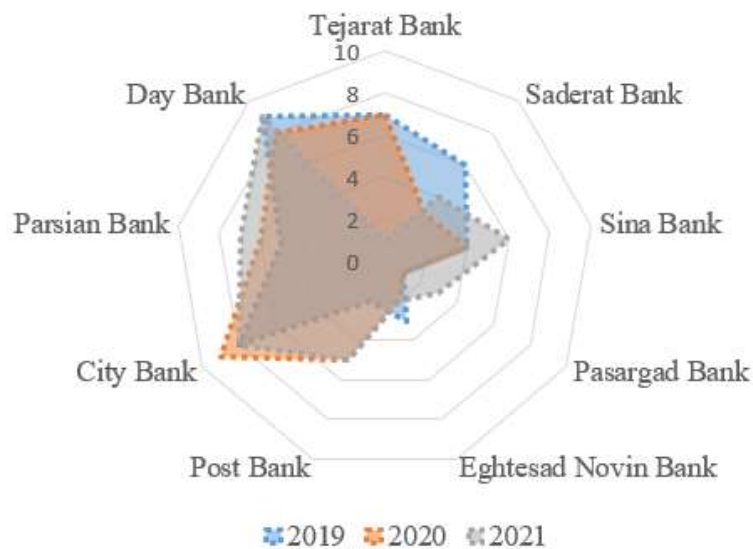


Figure 9. The final ranking of Iranian commercial banks based on the MULTIMOORA approach during the Covid-19 crisis

5. Conclusion

The banking sector plays a pivotal role in the functioning of any modern economy, serving as the backbone for the flow of capital, credit, and financial services. When banks are financially resilient and able to withstand shocks, they can continue to provide the necessary financing to businesses, households, and other economic agents, enabling them to weather the storm and maintain their operations. Conversely, if banks become financially fragile or unstable, it can lead to a credit crunch, hampering economic activity and exacerbating the already dire consequences of the pandemic. The financial resilience of commercial banks during the COVID-19 pandemic is a critical issue that demands urgent attention and action. Maintaining the stability and soundness of the banking sector is paramount for sustaining financing to the real economy and preserving overall financial stability amidst the unprecedented challenges posed by the crisis. This is particularly crucial for Iran, where the economy has already been grappling with the crippling impact of international sanctions and the pandemic-induced disruptions.

In the case of Iran, the economic challenges posed by the COVID-19 pandemic have been compounded by the long-standing impact of international sanctions, which have severely restricted the country's access to global financial systems and markets. This has placed an even greater burden on the domestic banking sector, which has had to navigate a complex web of regulatory and operational constraints to continue supporting the real economy. Addressing the financial resilience of Iranian banks is, therefore, not only a matter of national importance but also a critical factor in the country's ability to weather the current crisis and lay the foundation for a sustainable economic recovery. Moreover, the COVID-19 pandemic has exposed the vulnerabilities and interdependencies within the global financial system, underscoring the need for a comprehensive and coordinated approach to strengthening the resilience of the banking sector. Policymakers and regulators around the world have a responsibility to implement robust measures to ensure that banks are equipped to withstand future shocks, whether they are pandemic-related, economic, or geopolitical in nature.

In this regard, this study employs a multi-criteria decision-making (MCDM) approach that integrates the advantages of neutrosophic set. The stepwise weight assessment ratio analysis (SWARA) approach is utilized within a neutrosophic setting to determine the weights of key criteria influencing the financial resilience of Iranian commercial banks, including debt structure, capital adequacy structure, leverage ratio, asset structure, and profitability. This approach effectively handles the uncertainty and ambiguity inherent in expert judgments, which is particularly relevant given the unprecedented nature of the COVID-19 crisis. The banks are then ranked using the multi-objective optimization on the basis of a ratio analysis plus the full

multiplicative form (MULTIMOORA) approach to provide a comprehensive evaluation of their financial resilience.

The findings reveal that Pasargad bank have been better equipped to navigate the unprecedented economic disruptions caused by the pandemic, maintaining their financial stability and capacity to continue supporting the real economy. On the other hand, Day bank appears to have been more vulnerable to the shocks, potentially facing greater difficulties in sustaining its operations and lending activities during this turbulent period. This underscores the varying levels of credit exposure and risk tolerance across different banks, highlighting the need for a nuanced approach to forecasting the adverse effects of the pandemic on the banking sector. Moreover, according to the experts used in this study, capital adequacy structure is the most important criterion and asset structure is the least important criterion in determining the financial resilience of banks.

While this study offers valuable insights, it is important to acknowledge its limitations. The analysis is based on a relatively small sample of nine banks listed on the Tehran Stock Exchange (TSE), and the findings may not be fully generalizable to the entire Iranian banking sector. Future research could expand the sample size, incorporate additional financial and non-financial criteria, and explore the long-term implications of the pandemic on the financial resilience and performance of commercial banks in Iran.

References

- Aldasoro, I., Fender, I., Hardy, B., Tarashev, N. (2020). Effects of Covid-19 on the banking sector: the market's assessment, BIS Bulletins 12, Bank for International Settlements.
- Bakir, C. (2013). The Sources and Consequences of Bank Behaviour. *Bank Behaviour and Resilience: The Effect of Structures, Institutions and Agents*, 2013: p. 60-115. <https://doi.org/10.1057/9781137308160>
- World Bank (2020). COVID-19 to plunge global economy into worst recession since World War II. 2020, World Bank Group Washington, DC.
- Biswas, P., Pramanik, S., Giri, B.C. (2016). TOPSIS method for multi-attribute group decision-making under single-valued neutrosophic environment, *Neural computing and Applications*, 27, 727-737. <https://doi.org/10.1007/s00521-015-1891-2>
- Brauers, W.K., Zavadskas, E.K. (2006). The MOORA method and its application to privatization in a transition economy, *Control and Cybernetics*, 35(2), 445-469.
- Dahles, H. Susilowati, T.P. (2015). Business resilience in times of growth and crisis, *Annals of Tourism Research*, 51, 34-50. <https://doi.org/10.1016/j.annals.2015.01.002>
- Demir, G. (2022). Analysis of the financial performance of the deposit banking sector in the Covid-19 period with LMAW-DNMA methods, *International Journal of Insurance and Finance*, 2(2), 17-36. <https://doi.org/10.52898/ijif.2022.7>
- Guettafi, S., Laib, Y. (2016). Resilience and Stability of Algeria's Financial System towards—Resilience versus Stability—Approach. *Journal of Economics and Development Studies*, 4(1), 78-90. <http://dx.doi.org/10.15640/jeds.v4n1a8>
- Han, R., Melecky, M. (2013). Financial inclusion for financial stability: Access to bank deposits and the growth of deposits in the global financial crisis. World Bank policy research working paper, Report Number WPS6577.
- Karimi, A., Turkamani, H.S. (2021). US-imposed economic sanctions on Iran in the COVID-19 crisis from the human rights perspective. *International Journal of Health Services*, 51(4), 570-572. <https://doi.org/10.1177/00207314211024912>
- Rosenberg, T., Nada, G. (2022). Two Years of COVID: Economic Cost. Available from: <https://iranprimer.usip.org/blog/2022/feb/16/two-years-covid-economic-cost> (August 23, 2024).
- Nguyen, P.-H., Tsai, J.-F., Nguyen, V.-T., Vu, D.-D., Dao, T.-K. (2020). A decision support model for financial performance evaluation of listed companies in the Vietnamese retailing industry, *Journal of Asian Finance, Economics and Business*, 7(12), 1005-1015. <https://doi.org/10.13106/jafeb.2020.vol7.no12.1005>

Nguyen, P.H., Tsai, J.F., Hu, Y.C., Ajay Kumar, G.V. (2022). A Hybrid Method of MCDM for Evaluating Financial Performance of Vietnamese Commercial Banks Under COVID-19 Impacts. In: Abdul Karim, S.A. (eds) Shifting Economic, Financial and Banking Paradigm. Studies in Systems, Decision and Control, vol 382. Springer, Cham. <https://doi.org/10.1007/978-3-030-79610-5>

Bank for International Settlements (2009). Comprehensive response to the global banking crisis, Available from: <https://www.bis.org/press/p090907.htm> (August 23, 2024).

Shabir, M., Jiang, P., Wang, W., Isik, O. (2023). COVID-19 pandemic impact on banking sector: A cross-country analysis, Journal of Multinational Financial Management, 67, 100784. <https://doi.org/10.1016/j.mulfin.2023.100784>

Smarandache, F., Teodorescu, B., Teodorescu, M. (2016). Uncertainty Communication Solution in Neutrosophic Key, the Academic Department Resources at UNM Digital Repository. https://digitalrepository.unm.edu/math_fsp/282

Wilson, E. (2020). Coronavirus is cost and opportunity for Asia's banks. Euromoney. March 02, 2020. <https://www.euromoney.com/article/b1kl4kc07s51cv/coronavirus-is-cost-and-opportunity-for-asias-banks>