Supplementary Materials

Section 1: Defining concepts

S.1.1. Contributions

This section elaborates on the contributions of the present study from practical and theoretical perspectives. Different sub-sections are dedicated to each topic in order to better illustrate the implications of this research.

A. Practical and managerial contributions

The banking system of Iran faces major problems due to the sanctions and the overall economic status of the country. In addition to these threats, there are opportunities created due to people's need for financial institutions for safeguarding their financial assets and making profit. Bank managers must first and foremost make a detailed evaluation of the current status of their bank in order to take advantage of the existing opportunities and avoid the threats, so as to eventually be able to make appropriate decisions and adapt the right strategies to improve their bank's status. The framework proposed in this study can assist the managers in the following ways.

1- Restriction of the budget and resources available to the banks forces the managers to choose and implement the very best of the countless ways and strategies available for boosting the performance and financial soundness of the bank. The best strategies are achieved after acquiring a sound and comprehensive understanding of the bank's current status and its existing weaknesses and strengths. To achieve this goal, it is essential to closely examine the least and most effective indicators that impact the bank and all the private banks.

2- There are many indicators available to the managers for the purpose of performance assessment of the banks. However, none of them make it possible to have a comprehensive assessment of the bank's status from various financial aspects as best as the CAMELS indicators (Capital adequacy, Asset quality, Management, Earning, Liquidity, and Sensitivity to market risk) do. In the present study, we needed to conduct a multilayered performance. In addition to periodical assessment of each bank and ranking the indicators in terms of the bank's performance, we also determined the ranking of all the banks in terms of each individual indicator and the total ranking of all the banks in all considered time periods.

3- Determination of the banks' strengths and weaknesses will not lead to the overall improvement of their status by itself. This is because external factors also impact the decisions that managers make and the policies they adapt as well as the banking system inputs. Consequently, these factors, including the existing threats and opportunities, must also be taken into consideration in addition to the strengths and weaknesses. The improvement measures and strategies introduced in the present study based on a Strengths-Weaknesses-Opportunities-Threats (SWOT) matrix feature a combination of internal and external factors in order to ameliorate the existing conditions of private banks in Iran.

B. Theoretical and research contributions

While the framework suggested in this study is tailored to private banks in Iran, the comprehensive quantitative and qualitative analysis that it presents can be applied to all types of banks in any country. The contributions of this study to the existing literature on this subject are outlined below.

1- Despite the fact that a number of studies on performance assessment of banks have adopted strictly quantitative methods and mathematical models, the quantitative and qualitative perspectives that our research advances will facilitate realizing the ultimate goal of performance assessment, which is to improve the current status of each organization.
2- To evaluate the performance of banks, many researchers rely on questionnaires that are based on respondents' personal opinions. This might be due to the fact that the researchers do not have access to real data, because of possible limitations and incompleteness of reports. In the present research, however, we had access to 165 financial statements and balance sheets of private banks admitted to the Iranian stock exchange. We were consequently able to conduct the necessary financial computations with the accuracy required to obtain the value of each financial ratio. As a result, the preliminary data in our study feature a high accuracy and validity.
3- The results of sensitivity analysis and mathematical models used in the present research were validated using other mathematical models and statistical methods so as to increase the accuracy and reliability of the findings.

S.1.2. CAMELS indicator

The definition of each CAMELS indicator is elaborated at below:

C: Capital adequacy

Capital adequacy focuses on the total risk weighted capital that is intended to protect the depositors from the potential shocks of losses that a bank might incur. It is appraised based on the volume of risk assets, the volume of marginal and inferior assets, bank growth experience, plans, and prospects; and the strength of management in relation to all these factors [1]. Two different ratios have been proposed for this indicator:

- Capital adequacy ratio: It is obtained via dividing shareholders' respective liquidity by the amount of risk each shareholder takes [2].
- Ownership ratio: It is calculated via dividing shareholders' respective equity by the total assets [3].

A. Asset quality

This indicator examines the risk of a bank's assets. For example, a high-risk personal bank loan or grant financing is likely to be problematic. There are two important ratios for Asset quality:

- Ratio of earning assets to overall assets: While assets such as cash or buildings are also necessary for a bank, one of the ratios that can determine the quality of a bank's assets is the ratio of its Earning assets to its overall assets. Earning assets are formed for profit or fee and include facilities, investments, contributions, demands, and bonds. This ratio is calculated through dividing total income assets by the sum of all bank assets [4].
- Ratio of non-current facilities to total facilities: Facilities are divided into four categories according to the length of time it takes them to undergo failure: 1) Current facilities, 2) facilities with final maturity, 3) confirmed facilities, and 4) doubtful facilities. The Ratio of Non-Current Facilities to Total Facilities is obtained through dividing the sum of the items in the second, third, and fourth categories by all facilities. Non-current facilities involve a high risk of return due to their long duration [5].

M. Management

A good manager can reduce costs, increase profits, and even find ways to overcome problems under unfavorable conditions. Four ratios can be used for the Management indicator:

- Ratio of attraction of deposits to employees: This is equal to the ratio of total bank deposits to the total number of employees in all bank branches. The presence of any person in the organization entails some cost. This ratio is considered in the report on financial soundness and performance of Iranian banks provided by the National Audit Organization (NAO).
- Ratio of attraction of deposits to branches: The management of each bank branch has many costs, such as building costs and energy costs. In this ratio, the total amount of deposits is divided by the number of bank branches in the country. This ratio also appears in the NAO report on Iranian banks' financial soundness and performance.
- Ratio of income to employees: It is calculated through dividing the bank's income by the total number of employees in all its branches [6].
- Ratio of income to branches: It is calculated through dividing the bank’s income by the total number of its branches. This ratio, too, can be found in the NAO report on the performance and financial soundness of Iranian banks.

E. Earning

If the bank does not have sufficient Earning, it will incur accumulated costs and, sooner or later, will reach bankruptcy. There exist two common ratios for this indicator:

- Return on asset: This ratio is obtained through dividing the net profit calculated for each audit period to the bank's total assets [7].
- Return on equity: It is obtained through dividing the net profit by the bank's total capital [8].

L. Liquidity

The presence of sufficient liquidity in a bank ensures that it passes through unfavorable conditions and maintains its health. The Liquidity indicator has two ratios.

- Fluctuating coating ratio: It equals the bank's evaded deposits (i.e, the sum of savings deposits and visible deposits in the balance sheet) [8].
- Ratio of volatile debt: Temporary debt is calculated via dividing volatile deposits by all bank deposits (scope and stability). This ratio exists in the financial soundness and performance reports provided by the Iranian NAO. This ratio is of the-smaller-the-better (STB) type.

S. Sensitivity to market risk

Sensitivity to market risk is generally described as the degree to which changes in interest rates, foreign exchange rates, commodity prices, or equity prices can adversely affect Earning and/or capital. The following ratio was used to calculate this indicator.
Ratio of investments in the stock market to total assets: This is calculated through dividing a bank's investment in securities by its total assets.

- Due to the risk in portfolio investments, this ratio is of the-smaller-the-better type [9].

S.1.3. Best Worst Method

Best Worst Method (BWM) is a pairwise comparison method that provides more reliable results than similar methods [10-13]. A major advantage of BWM that encouraged us to use it is that it requires fewer pairwise comparisons than the Analytical Hierarchy process (AHP) method. The number of pairwise comparisons in AHP is determined based on Equation S1:

$$(r \times (r-1))/2 \qquad (S1)$$

But the number of pairwise comparisons in BWM is obtained based on Equation S2:

$$(2 \times r)-3 \qquad (S2)$$

where r is the number of indicators.

The weights achieved from BWM are highly reliable because they provide more consistent comparisons than AHP. While the consistency ratio in other MCDM methods is used to specify whether the comparisons are reliable or not, in BWM this ratio is used to measure the degree of reliability because the output of BWM is already consistent.

Additionally, the two-way comparisons used in the Best Worst Method require the use of experts who could make effective decisions. In this study, we consulted ten relevant experts working in financial organizations in Iran. After the indicators needed for the assessment were defined, a consensus was reached based on experts' opinions to select the most important and the least important indicators. Next, each expert compared the most important indicator, as he/she prioritized it, with other indicators one by one. The numbers 1 to 9 were used to show the importance of indicators. In the next step, using a number between 1 and 9, each expert compared

each indicator individually with the least important indicator. Once the experts reached a consensus, Model $(S1)$ was used to calculate the geometric mean and determine the optimal weight of each indicator [14].

Model $(S1)$:

$$\min \psi \qquad (S3)$$

$$s.t$$

$$\left|w_b - a_{br} w_r\right| \le \psi \qquad r = 1,\ldots,s \qquad (S4)$$

$$\left|w_r - a_{rw} w_w\right| \le \psi \qquad r = 1,\ldots,s \qquad (S5)$$

$$w_r \le w_b \qquad (S6)$$

$$w_r \ge w_w \qquad (S7)$$

$$\sum_{r=1}^{k} w_r = 1 \qquad (S8)$$

$$w_r \ge 0 \qquad r = 1,\ldots,s \qquad (S9)$$

In model $(S1)$, w_b is the weight of the most critical indicator, w_w is the weight of the least important indicator, w_r is the weight of the r-th indicator, a_{br} The priority of the most important indicator over the r-th indicator, and a_{rw} shows the position of r-th indicator relative to the least important indicator. In addition, according to [15], ψ shows the consistency rate of experts' opinions: if it is less than 0.1, the comparison has been executed correctly. The BWM was finally used to weigh each indicator.

S.1.4. Data Envelopment Analysis

The efficiency score of an organization with multiple outputs and inputs is generally defined as the ratio of the weighted sum of outputs to the weighted sum of inputs. A clear drawback of this definition is the dependency of efficiency scores on calculating the weights while different weights lead to different efficiency scores. In contrast to this common method, Data Envelopment Analysis (DEA) obtains the optimal weights for maximizing the efficiency score of an organization. First introduced by Charnes, Cooper [16], DEA is one of the most popular methods for measuring the efficiency of different branches with similar inputs and outputs, commonly known as decision-making units (DMUs) [17-21]. DEA is a nonparametric method based on linear programming that is

used for performance evaluation of different organizations, including factory [22-24], mine [25], hospital [26, 27], transportation system [28, 29], educational system [30], road accident [31] bank [32], etc. More recently, this model has been improved through incorporating features from such as fuzzy and robust problems [33]. The present study applied the CAMELS indicators on 11 private banks (DMUs) over a period of six months. Finally, the efficiency score of each DMU was calculated to understand the exact performance of each bank in terms of the CAMELS indicators. DEA offers several advantages that make it an attractive technique for research. For instance, in the DEA technique, there is no need to express the mathematical form of the relationship between inputs and outputs. Rather, this relationship is determined based on the input and output values themselves, which makes DEA a nonparametric method. Additionally, it allows the simultaneous application of several inputs and outputs. Most importantly, DEA could be used to explore the factors contributing to the inefficiency of organizations.

In the present study, the DEA model introduced by Toloo [34] is used to identify the top DMUs. According to Equation S10, in order to convert the STB ratio to the ratio of the desired type, (larger-the-better, or LTB), we invert this ratio and then use Equation S11 to normalize all available data [17].

$$x_{rij} = \begin{cases} x_{rij} & \text{if the indicator is LTB} \\ \dfrac{1}{x_{rij}} & \textit{otherwise} \end{cases} \qquad \begin{array}{l} r = 1,2,\ldots,s \\ i = 1,2,\ldots,m_r \\ j = 1,2,\ldots,n \end{array} \qquad (S10)$$

$$z_{rij} = \frac{X_{rij} - Min\{x_{ri}\}}{Max\{x_{ri}\} - Min\{x_{ri}\}} \qquad \begin{array}{l} r = 1,2,\ldots,s \\ i = 1,2,\ldots,m_r \\ j = 1,2,\ldots,n \end{array} \qquad (S11)$$

$$Z_{rj} = \frac{1}{m_r}\sum_{i=1}^{m_r} z_{rij} w'_{ri} \qquad \begin{array}{l} r = 1,2,\ldots,s \\ i = 1,2,\ldots,m_r \\ j = 1,2,\ldots,n \end{array} \qquad (S12)$$

$$w'_{ri} = W_r w_{ri} \qquad \begin{array}{l} r = 1,2,\ldots,s \\ i = 1,2,\ldots,m_r \end{array} \qquad (S13)$$

$\text{Max}\{x_{ri}\}$ and $\text{Min}\{x_{ri}\}$ are the maximum and minimum numbers in the i-th ratio of the r-th indicator, while z_{rij} is a normal number placed in the interval between [1 and 0]. Next, according to Equation S12, the actual value of each indicator in each DMU is obtained.

In Equation S12, z_{rj} is the actual value of each indicator in each DMU, m_r is equal to the number of ratios associated with the r-th indicator, and, w'_{ri} is the final weight of the i-th ratio; according to Equation S11, this value is determined through multiplying the DMU-obtained weight for the r-th indicator by the weight of the i-th sub-indicator of that indicator. Model (S2) will be derived from

Equation S14. According to this model, the efficiency score of the best DMU is denoted by δ_j while the importance coefficients of each indicator are denoted by u_r. The binary variable G ensures that only one DMU is the most efficient, and the variables M and ε denote a big number and a small number.

Model (2):

$$min\ \delta_{max} \qquad (S14)$$

$$s.t$$

$$\delta_{max} - \delta_j \geq 0 \qquad j = 1,\ldots,n \qquad (S15)$$

$$\sum_{r=1}^{s} u_r Z_{rj} + \delta_j = 1 \qquad r = 1,\ldots,n \quad j = 1,\ldots,n \qquad (S16)$$

$$\sum_{j=1}^{n} G_j = n - 1 \qquad (S17)$$

$$\delta_j \leq G_j \qquad j = 1,\ldots,n \qquad (S18)$$

$$G_j \leq M\delta_j \qquad j = 1,\ldots,n \qquad (S19)$$

$$\delta_j \geq 0 \qquad j = 1,\ldots,n \qquad (S20)$$

$$u_r \geq \varepsilon \qquad r = 1,\ldots,n \qquad (S21)$$

$$G_j \in \{0,1\} \qquad j = 1,\ldots,n \qquad (S22)$$

In this model, as shown in Equation S14, the objective is to reduce the maximum impact of the efficiency scores. Equation S15 indicates that all efficiency scores should be smaller than the maximum efficiency score in the problem. Equation S16 represents the efficiency of each metric. Equations S17 through S19 ensure that only one DMU is the most efficient; Equation S17 allows only zero δ associated with the best DMU, while Equations S18 and S19 indicate that deviation from efficiency will be zero only if $G = 0$, but if $G = 1$, then the efficiency score is a non-zero. Note that after Model (S2) is solved, δ_j represents the deviation from the most probable efficiency. To determine the performance score, one must calculate $(1 - \delta_j)$.

S.1.5. Sensitivity Analysis

The results were also statistically examined for more detailed analysis. It should be noted that there are two different categories of statistical tests: parametric and nonparametric. In parametric tests, performance values must be checked under three conditions simultaneously, and if even one of these conditions is not met, the parametric test cannot be used [35]: 1) independence, 2) normality, and 3) homogeneity. In the present study, we used the Kolmogorov-Smirnov and Levene's tests to check the normality condition and the homogeneity condition, respectively [22].

S.1.6. SWOT Analysis

SWOT analysis is one of the most powerful tools for exploring and designing effective strategies to deal with desirable and undesirable situations in an organization [36]. Organizations benefit from this popular method thanks to its capacity to create a competitive environment [37]. SWOT analysis includes four aspects in two dimensions: While strengths and weaknesses are internal components and are related to the organization, opportunities and threats are external factors of the environment. These four segments are represented in a 2×2 matrix. Strengths and weaknesses are usually discovered by sensitivity analysis. Strengths and opportunities encourage organizations and contribute to accomplishing organizational objectives, but weaknesses and threats impede the realization of these targets and are unfavorable for organizations. Hence, any successful selection of strategies is predicated on the proper analysis of the organization's internal strengths and weaknesses associated with the internal environment as well as opportunities and threats coming from the external environment. Indeed, the manager is in charge of adjusting the analysis of external and internal factors in order to balance the organization's strengths and weaknesses on the basis of environmental opportunities and threats. Therefore, in this study we run this analysis to identify effective strategies for performance evaluation of 11 Iranian private banks in terms of sustainability, resilience, and sales-marketing indicators. Moreover, four different strategies are developed for by applying this method [38]: 1) Strengths-Opportunities, 2) Strengths-Threats, 3) Weaknesses-Opportunities, and 4) Weaknesses-Threats.

S.1.7. Principal Component Analysis

The principal component analysis (PCA) is an important multivariate statistical method for reducing problem dimensions and ranking DMUs. In this method, the indicators of the problem are measured through dividing the k-th output of the j-th DMU by the h-th input of the j-th DMU (d_{hk}^{j}) .Finally, the DMUs are ranked based on their respective score. [39]. This procedure is detailed below:

Step 1: First, Equation S23 is used to obtain a PCA indicator. Here, the input of each DMU is denoted by x_{hj} and the output is denoted by y_{kj} . As mentioned earlier, the main components of the problem have an incremental quality. Therefore, all components will be of the output type. To solve this problem, we use a virtual input, which replaces x_{hj} with a value of 1 in Equation 23 [40]. Thus, d_j^u represents the final value of the indicator u-th in the DMU j-th.

$$d_u^j = d_{hk}^j = \frac{y_{kj}}{x_{hj}} = y_{kj} \qquad \begin{matrix} j = 1,\ldots,165 \\ k = 1,\ldots,6 \end{matrix} \qquad (S23)$$

Step 2: Equation S24 is used to calculate the eigenvalues (*) and eigenvectors (*) of the correlation matrix (matrix R) obtained in the first step. Here 6×6 is used as the I_p matrix.

$$\left|R - \alpha I_p\right| = 0 \qquad p = 1,\ldots,6 \qquad (S24)$$

Step 3: In this step, we multiply the values of the matrix obtained from the first step by the corresponding eigenvector values; also, the sum of the resulting values of $(PCA)_i$ corresponding to each DMU is recorded according to Equation S25 [41].

$$\vartheta_m = \sum_{u=1}^{6} d_u^j \beta_{mu} \qquad \begin{matrix} m = 1,\ldots,6 \\ j = 1,\ldots,165 \end{matrix} \qquad (S25)$$

Step 4: In the last step, according to Equation S26, we calculate the relative final value of each indicator through dividing its corresponding eigenvalue by the sum of eigenvalues. Consequently, through determining the sum of multiplying the relative final value by the values obtained in the third step, we obtain the final score of each DMU according to Equation S27 [22, 42] .

$$w_u = \frac{\alpha_u}{\sum_{u=1}^{6} \alpha_u} \qquad (S26)$$

$$score_j = \sum_{u=1}^{6} w_u \vartheta_u \qquad j = 1,\ldots,165 \qquad (S27)$$

Section 2: Detailed results

S.2.1. Comparation of indicators in BWM

Tables S1 and S2 present the geometric mean of the experts in the most important indicator (management), the least important indicator (Sensitivity to market risk), as well as other studied indicators.

Table S1. *Management preferences on other indicators*

The most important indicator	Capital adequacy	Asset quality	Management	Management	Earning	Sensitivity to market risk

Management	2.550	2.733	1	1	4.638	5.988

Table S2*. The priority of each indicator over Sensitivity to market risk*

The least important indicator	Sensitivity to market risk
Capital adequacy	3.836
Asset quality	3.837
Management	5.988
Earning	3.211
Liquidity	2.352
Sensitivity to market risk	1

S.2.2. Discussion on CAMELS results

- Considering the indicator of Capital adequacy, Banks B9, B1, and B8 have the best performance and Banks B4, B7, B2, and B11 show the weakest performance, respectively. Also, Bank B9 is the most consistent in terms of this indicator during 15 different time periods.
- Considering the indicator of Asset quality, Banks B7, B6, and B11, show the best performance, and Banks B1, B8, and B9 show the weakest performance, respectively. Also, Bank B9 is the most consistent in terms of this indicator during 15 different time periods.
- Considering the indicator of Management, Banks B6, B11, and B10 show the best performance, and Banks B9, B2, and B1 show the weakest performance, respectively. Also, Bank B4 is the most consistent in terms of this indicator during 15 different time periods.
- Considering the indicator of Earning, Bank B9, B7, and B3 show the best performance, and Bank B11, B10, and B6 show the weakest performance, respectively. Also, Bank B6 is the most consistent in terms of this indicator during 15 different time periods.
- Considering the indicator of Liquidity, Banks B5, B3, and B1 show the best performance, and Banks B7, B6, and B8 show the weakest performance, respectively. Also, Bank B8 is the most consistent in terms of this indicator during 15 different time periods.
- Considering the indicator of Sensitivity to market risk, Banks B7, B11, and B5 show the best performance, and Banks B10, B1, and B2 show the weakest performance, respectively. Also, Bank B9 is the most consistent in terms of this indicator during 15 different time periods.

S.2.3. Discussion on statistical tests

As can be observed in the figure, in the case of Asset quality, all of the 95-percent confidence intervals of each bank overlap with the confidence interval of each of the other 10 banks. Hence, the intuitive results on this indicator are not confirmed, and statistically the average performance of different banks does not show a significant difference from this perspective. As for other indicators, there is at least one bank whose 95-percent confidence interval is not identical with at least one

other bank. Therefore, the hypothesis of equality of all means is rejected. In the case of these five indicators for which the null hypothesis is rejected, the least significant difference (LSD) test was used to conduct a pairwise comparison of the mean performance of private banks. The results are presented in Table S1.

If the P-value of any pairwise comparison is less than 0.05, the hypothesis of equality of the means of the two banks under consideration is statistically rejected. Apropos of Capital adequacy, Banks B9, B1, and B8 are associated with the best performance, but their performance in this regard is not significantly different from each other. In terms of the Management indicator, Banks B6, B11, and B10 are not significantly different and they all display the best performance. As far as the Earning indicator is concerned, there is no statistically significant difference between Banks B9, B1, and B10, and these banks deliver the best performance. Meanwhile, there is no statistically significant difference between the performance of any of the 11 private banks when it comes to the Liquidity indicator, and it cannot be claimed that one bank is superior to the others from this point of view. Finally, regarding Sensitivity to market risk, the performance of Banks B1, B2, B3, B4, B6, B7, B8, B9, and B10 is not significantly different from each other, yet they perform better than Banks B5 and B11

S.2.4. Results of LSD test

Table S3*. The results of pairwise comparison of the mean performance in LSD test*

Difference of levels	P-value of LSD test				
	Capital Adequacy	Management	Earning	Liquidity	Sensitivity to market risk
B2 - B1	0.026	0.625	0	0.151	0.936
B3 - B1	0.033	0.803	0	0.16	0.13
B4 - B1	0.018	0.504	0	0.735	0.194
B5 - B1	0.032	0.379	0	0.001	0.003
B6 - B1	0.059	0	0	0.015	0.816
B7 - B1	0.018	0.316	0	0.011	0
B8 - B1	0.943	0.776	0	0.018	0.312
B9- B1	0.351	0.223	0	0.028	0.746
B10 - B1	0.059	0.095	0	0.869	0.939
B11 - B1	0.026	0.04	0	0.616	0
B3 - B2	0.921	0.461	0.901	0.005	0.152
B4 - B2	0.885	0.248	0.526	0.272	0.223
B5 - B2	0.934	0.172	0.745	0	0.004
B6 - B2	0.733	0	0.536	0.315	0.878
B7 - B2	0.891	0.137	0.924	0.258	0
B8 - B2	0.031	0.44	0.351	0.348	0.351
B9 - B2	0.002	0.463	0.823	0.437	0.807
B10 - B2	0.73	0.032	0.024	0.204	0.876
B11- B2	0.999	0.011	0.905	0.349	0
B4 - B3	0.808	0.675	0.611	0.082	0.829
B5 - B3	0.987	0.528	0.841	0.042	0.142

B6 - B3	0.809	0	0.621	0	0.2
B7 - B3	0.813	0.451	0.826	0	0.005
B8 - B3	0.04	0.971	0.419	0	0.614
B9 - B3	0.002	0.143	0.921	0	0.233
B10 - B3	0.806	0.155	0.033	0.117	0.112
B11- B3	0.92	0.071	0.807	0.058	0.032
B5 - B4	0.821	0.832	0.757	0	0.093
B6 - B4	0.627	0	0.988	0.036	0.286
B7 - B4	0.994	0.738	0.466	0.027	0.003
B8 - B4	0.022	0.701	0.765	0.043	0.773
B9 - B4	0.001	0.06	0.682	0.062	0.328
B10 - B4	0.625	0.315	0.103	0.863	0.169
B11 - B4	0.886	0.164	0.452	0.871	0.019
B6 - B5	0.796	0	0.769	0	0.006
B7 - B5	0.827	0.902	0.674	0	0.179
B8 - B5	0.038	0.551	0.543	0	0.049
B9 - B5	0.002	0.037	0.92	0	0.008
B10 - B5	0.793	0.428	0.053	0.001	0.003
B11 - B5	0.933	0.237	0.657	0	0.495
B7 - B6	0.633	0	0.475	0.9	0
B8 - B6	0.069	0	0.753	0.946	0.436
B9 - B6	0.005	0	0.693	0.819	0.928
B10 - B6	0.997	0	0.1	0.024	0.757
B11 - B6	0.732	0	0.461	0.053	0.001
B8 – B7	0.022	0.473	0.305	0.847	0.001
B9 – B7	0.001	0.027	0.749	0.723	0
B10 – B7	0.63	0.502	0.019	0.017	0
B11 – B7	0.892	0.289	0.981	0.04	0.506
B9 - B8	0.316	0.133	0.479	0.872	0.491
B10 - B8	0.069	0.166	0.181	0.028	0.277
B11 - B8	0.031	0.076	0.293	0.062	0.009
B10 - B9	0.005	0.004	0.042	0.041	0.69
B11 - B9	0.002	0.001	0.731	0.088	0.001
B11 - B10	0.729	0.695	0.018	0.737	0

S.2.5. Results of DEA Model

Table S4*. Efficiency Score and Different DMUs Rank Using DEA Model*

Unit name	Efficiency score	Rank	Unit name	Efficiency score	Rank	Unit name	Efficiency score	Rank
DMU1	0.150	147	DMU56	0.168	133	DMU111	0.129	155
DMU2	0.218	90	DMU57	0.198	107	DMU112	0.127	158
DMU3	0.134	153	DMU58	0.501	25	DMU113	0.203	104
DMU4	0.176	129	DMU59	0.195	115	DMU114	0.617	17

DMU5	0.141	149	DMU60	0.233	79	DMU115	0.224	85
DMU6	0.271	66	DMU61	0.213	94	DMU116	0.215	92
DMU7	0.934	7	DMU62	0.219	88	DMU117	1.000	6
DMU8	0.211	97	DMU63	0.195	114	DMU118	0.566	19
DMU9	0.115	161	DMU64	0.212	95	DMU119	0.163	137
DMU10	0.790	8	DMU65	0.197	111	DMU120	0.126	160
DMU11	0.622	16	DMU66	0.574	18	DMU121	0.169	132
DMU12	1.000	2	DMU67	0.264	69	DMU122	0.384	40
DMU13	0.662	12	DMU68	0.428	35	DMU123	0.183	123
DMU14	1.000	3	DMU69	0.486	26	DMU124	0.164	136
DMU15	0.718	11	DMU70	0.276	63	DMU125	0.159	139
DMU16	0.135	151	DMU71	0.419	36	DMU126	0.190	118
DMU17	0.166	135	DMU72	0.447	29	DMU127	0.199	106
DMU18	0.101	165	DMU73	0.433	34	DMU128	0.199	105
DMU19	0.167	134	DMU74	0.440	31	DMU129	0.189	120
DMU20	0.128	156	DMU75	0.391	39	DMU130	0.218	89
DMU21	0.150	146	DMU76	0.363	45	DMU131	0.207	101
DMU22	0.181	125	DMU77	1.000	4	DMU132	0.246	74
DMU23	0.170	131	DMU78	0.197	108	DMU133	0.221	86
DMU24	0.126	159	DMU79	0.332	49	DMU134	0.230	82
DMU25	0.196	112	DMU80	0.249	72	DMU135	0.239	76
DMU26	0.141	150	DMU81	0.328	51	DMU136	0.197	109
DMU27	0.184	122	DMU82	0.272	65	DMU137	0.212	96
DMU28	0.189	119	DMU83	0.414	37	DMU138	0.220	87
DMU29	0.155	142	DMU84	0.307	57	DMU139	0.283	61
DMU30	0.131	154	DMU85	0.457	28	DMU140	0.309	56
DMU31	0.189	121	DMU86	0.329	50	DMU141	0.357	47
DMU32	0.225	84	DMU87	0.555	21	DMU142	0.438	32
DMU33	0.246	73	DMU88	0.401	38	DMU143	0.313	55
DMU34	0.301	58	DMU89	0.628	14	DMU144	0.232	80

DMU35	0.210	99	DMU90	0.635	13	DMU145	0.458	27
DMU36	0.216	91	DMU91	0.383	42	DMU146	0.327	52
DMU37	0.154	144	DMU92	0.227	83	DMU147	0.433	33
DMU38	0.732	10	DMU93	1.000	1	DMU148	0.350	48
DMU39	0.506	23	DMU94	0.561	20	DMU149	0.384	41
DMU40	0.377	44	DMU95	1.000	5	DMU150	0.288	60
DMU41	0.197	110	DMU96	0.157	141	DMU151	0.234	78
DMU42	0.316	54	DMU97	0.154	143	DMU152	0.177	127
DMU43	0.237	77	DMU98	0.151	145	DMU153	0.541	22
DMU44	0.243	75	DMU99	0.135	152	DMU154	0.214	93
DMU45	0.196	113	DMU100	0.160	138	DMU155	0.781	9
DMU46	0.296	59	DMU101	0.143	148	DMU156	0.444	30
DMU47	0.231	81	DMU102	0.362	46	DMU157	0.505	24
DMU48	0.194	116	DMU103	0.259	70	DMU158	0.177	128
DMU49	0.269	68	DMU104	0.279	62	DMU159	0.257	71
DMU50	0.204	103	DMU105	0.159	140	DMU160	0.270	67
DMU51	0.625	15	DMU106	0.128	157	DMU161	0.276	64
DMU52	0.182	124	DMU107	0.110	164	DMU162	0.325	53
DMU53	0.205	102	DMU108	0.211	98	DMU163	0.379	43
DMU54	0.150	126	DMU109	0.115	162	DMU164	0.208	100
DMU55	0.218	117	DMU110	0.114	163	DMU165	0.174	130

S.2.6. Sensitivity analysis for all private banks in general

The results of the Kolmogorov-Smirnov and Levene's tests are shown in Table S5 for all 165 DMUs of the private banks. It is clear that the three conditions were not met by removing any of the six indicators. Therefore, the Wilcoxon nonparametric test was used.

Table S5*. P-values for different scenarios for all private banks in general based on results of Kolmogorov-Smirnov test and Levene's test*

Omitted indicator	P-value						
	None	Capital Adequacy	Asset quality	Management	Earning	Liquidity	Sensitivity to market risk
Kolmogorov-Smirnov test	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Levene's test	-	0.058	0.248	0.102	0.113	0.271	0.487

S.2.7. Sensitivity analysis for each private bank individually

Table S6*. P-value of the Kolmogorov-Smirnov test and Levene's test*

Omitted indicator	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11
	P-value of the Kolmogorov-Smirnov test										
None	0.010	0.200	0.003	0.000	0.170	0.107	0.011	0.000	0.088	0.200	0.039
Capital Adequacy	0.004	0.200	0.200	0.001	0.200	0.000	0.001	0.000	0.001	0.200	0.181
Asset quality	0.019	0.200	0.136	0.000	0.052	0.172	0.002	0.000	0.036	0.200	0.016
Management	0.114	0.091	0.000	0.000	0.200	0.000	0.003	0.000	0.200	0.200	0.057
Earning	0.200	0.200	0.001	0.000	0.200	0.034	0.001	0.000	0.200	0.200	0.161
Liquidity	0.001	0.200	0.050	0.003	0.079	0.108	0.011	0.000	0.146	0.200	0.035
Sensitivity to market risk	0.027	0.200	0.200	0.005	0.001	0.200	0.001	0.000	0.002	0.200	0.000
	P-value of Levene's test										
Capital Adequacy	0.792	0.755	0.111	0.889	0.001	0.524	0.534	0.179	0.814	0.258	0.663
Asset quality	0.990	0.314	0.946	0.902	0.412	0.288	0.983	0.612	0.476	0.113	0.959
Management	0.000	0.834	0.236	0.893	0.147	0.772	0.979	0.297	0.258	0.082	0.945
Earning	0.000	0.552	0.289	1	0.095	0.698	0.993	0.485	0.278	0.164	0.968
Liquidity	0.509	0.902	0.008	0.301	0.002	0.993	0.697	0.926	0.926	0.164	0.915
Sensitivity to market risk	0.730	0.855	0.041	0.280	0.000	0.200	0.982	0.593	0.640	0.076	0.769

- Bank B1 performed well in terms of Capital adequacy, Management, Earning, Liquidity, and Sensitivity to market risk.
- Bank B2 performed well in terms of Capital adequacy, Management, Earning, and Sensitivity to market risk.
- Bank B3 performed well in terms of Capital adequacy, Earning, and Sensitivity to market risk.
- Bank B4 performed well in terms of Capital adequacy, Management, Earning, and Liquidity.
- Bank B5 performed well in terms of Capital adequacy, Earning, and Sensitivity to market risk.
- Bank B6 performed well in terms of Capital adequacy, Management, and Earning, but poorly in terms of Sensitivity to market risk.
- Bank B7 performed well in terms of Earning and Management, but poorly in terms of Asset quality and Sensitivity to market risk.
- Bank B8 performed well in terms of Management, Earning, and Sensitivity to market risk.
- Bank B9 performed well in terms of Capital adequacy, Asset quality, and Sensitivity to market risk.
- Bank B10 performed well in terms of Capital adequacy, Management, Earning, and Liquidity, but poorly in terms of Asset quality.
- Bank B11 performed well in terms of Capital adequacy but poorly in terms of Earning.

S.2.8. Sensitivity analysis for each indicator

- According to Figure 6, in terms of Capital adequacy, Bank B6 is the most positively impacted and B2 Bank is the least positively impacted, while none of the banks are negatively impacted.
- According to Figure 7, in terms of Asset quality, Bank B9 is the most positively impacted and Bank B5 is the least positively impacted, while Bank B6 is the most negatively impacted and Bank B5 is the least negatively impacted.
- According to Figure 8, in terms of the Management indicator, Bank B6 is the most positively impacted and Bank B5 is the least positively impacted, while only 3B Bank is negatively impacted.
- According to Figure 9, in terms of the Earning indicator, Bank B1 is the most positively impacted and Bank B2 is the least positively impacted, while Bank B3 is the most negatively impacted and Bank B5 is the least negatively impacted.
- According to Figure 10, in terms of Liquidity, Bank B3 is the most positively impacted and Bank B2 is the least positively impacted, while Bank B8 is the most negatively impacted and Bank B7 is the least negatively impacted.
- According to Figure 11, in terms of Sensitivity to market risk, Bank B5 is the most positively impacted and Bank B8 is the least positively impacted, while Bank B6 is the most negatively impacted and Bank B10 is the least negatively impacted.

S.2.9. PCA results

Table S7. *Results from PCA rankings*

Unit Name	PCA Score	Rank	Unit Name	Unit Name	PCA Score	Rank	Unit Name	PCA Score	Rank	Unit Name	PCA Score	Rank
DMU1	0.128	101	DMU43	DMU43	0.185	119	DMU85	0.259	139	DMU127	-0.177	24
DMU2	0.183	117	DMU44	DMU44	0.098	83	DMU86	0.176	116	DMU128	-0.113	32
DMU3	0.089	79	DMU45	DMU45	0.063	69	DMU87	0.297	146	DMU129	-0.164	25
DMU4	0.138	106	DMU46	DMU46	0.272	140	DMU88	0.255	138	DMU130	-0.147	28
DMU5	0.020	55	DMU47	DMU47	0.128	102	DMU89	0.328	151	DMU131	-0.081	37
DMU6	0.184	118	DMU48	DMU48	0.141	107	DMU90	0.442	158	DMU132	-0.020	48
DMU7	-1.438	4	DMU49	DMU49	0.192	123	DMU91	0.386	155	DMU133	-0.015	49
DMU8	0.252	135.5	DMU50	DMU50	0.163	115	DMU92	0.223	132	DMU134	-0.025	45
DMU9	0.054	65.5	DMU51	DMU51	0.249	133	DMU93	1.550	165	DMU135	-0.089	36
DMU10	-0.896	11	DMU52	DMU52	0.118	94	DMU94	-0.870	12	DMU136	0.020	56
DMU11	-1.016	9	DMU53	DMU53	0.194	124	DMU95	-1.238	6	DMU137	0.065	71
DMU12	-1.656	3	DMU54	DMU54	0.129	104	DMU96	0.116	92	DMU138	0.223	131
DMU13	-1.105	8	DMU55	DMU55	0.163	114	DMU97	0.124	100	DMU139	0.197	126
DMU14	-1.852	2	DMU56	DMU56	0.102	87	DMU98	0.107	88	DMU140	0.328	150
DMU15	-1.169	7	DMU57	DMU57	0.121	97	DMU99	0.051	64	DMU141	0.155	112
DMU16	-0.099	33	DMU58	DMU58	-0.827	13	DMU100	0.124	99	DMU142	-0.271	20
DMU17	-0.090	35	DMU59	DMU59	0.150	109	DMU101	0.122	98	DMU143	-0.039	43
DMU18	-0.0073	51	DMU60	DMU60	0.113	89	DMU102	0.291	144	DMU144	-0.177	23
DMU19	0.007	54	DMU61	DMU61	-	38	DMU103	0.286	143	DMU145	-	21

					0.081						0.243	
DMU20	0.000	52	DMU62	DMU62	-	41	DMU104	0.295	145	DMU146	-	22
					0.054						0.240	
DMU21	0.028	58	DMU63	DMU63	-	40	DMU105	0.048	62	DMU147	-	15
					0.056						0.391	
DMU22	-0.008	50	DMU64	DMU64	-	47	DMU106	0.116	91	DMU148	-	18
					0.020						0.293	
DMU23	0.049	63	DMU65	DMU65	-	39	DMU107	0.044	61	DMU149	-	16.5
					0.060						0.365	
DMU24	0.037	59	DMU66	DMU66	0.114	90	DMU108	0.252	135.5	DMU150	-	19
											0.282	
DMU25	0.155	113	DMU67	DMU67	0.275	142	DMU109	0.054	65.5	DMU151	0.097	82
DMU26	0.085	77	DMU68	DMU68	0.152	110	DMU110	0.072	74	DMU152	0.064	70
DMU27	0.133	105	DMU69	DMU69	0.523	160	DMU111	0.070	73	DMU153	0.549	161
DMU28	0.154	111	DMU70	DMU70	0.251	134	DMU112	0.093	80	DMU154	0.203	127
DMU29	0.101	86	DMU71	DMU71	0.273	141	DMU113	0.087	78	DMU155	-	14
											0.705	
DMU30	0.022	57	DMU72	DMU72	0.347	153	DMU114	-	10	DMU156	0.612	163
								0.9633				
DMU31	-0.035	44	DMU73	DMU73	0.420	156	DMU115	-	46	DMU157	0.720	164
								0.0248				
DMU32	0.004	53	DMU74	DMU74	0.372	154	DMU116	0.0427	60	DMU158	0.192	122
DMU33	0.142	108	DMU75	DMU75	0.309	148	DMU117	-1.435	5	DMU159	0.298	147
DMU34	0.120	95	DMU76	DMU76	-	31	DMU118	0.573	162	DMU160	0.322	149
					0.114							
DMU35	0.186	120	DMU77	DMU77	-	1	DMU119	0.117	93	DMU161	0.343	152
					2.314							
DMU36	0.100	84	DMU78	DMU78	-	42	DMU120	0.055	67	DMU162	0.445	159
					0.048							
DMU37	0.120	96	DMU79	DMU79	0.056	68	DMU121	-0.128	30	DMU163	0.438	157
DMU38	0.217	129	DMU80	DMU80	0.097	81	DMU122	-0.365	16.5	DMU164	0.075	76
DMU39	0.255	137	DMU81	DMU81	0.074	75	DMU123	-0.095	34	DMU165	0.101	85
DMU40	0.191	121	DMU82	DMU82	0.129	103	DMU124	-0.151	27			
DMU41	0.066	72	DMU83	DMU83	0.206	128	DMU125	-0.141	29			
DMU42	0.217	130	DMU84	DMU84	0.196	125	DMU126	-0.152	26			

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